THE
ENGINEERING MAGAZINE
THE WORLD IS ITS FIELD

VOL. XXXIX. JULY, 1910. No. 4.

THE TWELVE PRINCIPLES OF EFFICIENCY

AND THE ORGANIZATION WHICH MAKES THEIR APPLICATION POSSIBLE.

By Harrington Emerson.

In a preceding article, the first of this series, Mr. Emerson showed by historic examples the universal potency of certain efficiency principles. His examples were Prussia's unprecedented course of military conquest, Japan's marvellous success in war, and the industrial advance in both countries following the same policy of constructive organization and application of the "Twelve Principles." These principles are so certain in effectiveness that, in Mr. Emerson's words, they "give even the mediocre manager a greater possibility of attaining high efficiency than was ever possessed by the greatest industrial geniuses working along the old lines."

The application of these principles requires a special type of organization. It is not generally possible to introduce them until, by amending or supplementing the existing order, this constructive, defensive, functional type of organization is secured. The article now presented shows by natural analogy and contrast wherein the efficiency organization differs from the old military type. The succeeding papers will take up successively the "Twelve Principles" and discuss their application in industrial management.—THE EDITORS.

THE poor white trash of the southern States and the listless negroes have long been a by-word, but we suddenly find out that all these people, white and dark, are afflicted with a parasite, the hook worm, which saps their vitality, internally slowly bleeds their strength away.

The remedy is not schools, nor churches, nor the suppression of the saloon, nor the sternness of the task master—all excellent devices; the remedy is the elimination of the parasite. After this initial betterment, the principles of education, of religion, of temperance, of stimulus, may be confidently applied.

American organization for operation, whether governmental (army, navy, civil), whether state or municipal, whether for land-railroads or ocean-steamboats, whether educational or religious, whether industrial or commercial, proves on investigation to be inefficient, often disgracefully so, the efficiency of the output of men of militia age of the country as a whole being not more than 5 per cent, the efficiency of use of materials being not more than 60 per cent, the

efficiency of equipment, facilities, averaging not 30 per cent. These inefficiency statements can be verified from the facts, by any competent experts, as readily as an assayer can duplicate the assay of an ore sample.

Our material resources are unsurpassed, our workers are intelligent, ambitious, versatile, our equipment, from farm lands to office buildings, from typewriters up to Mallet compounds and down again to telephones, is lavish; yet it is all depreciated by an equally stupendous inefficiency. The principles of efficiency are simple, are plain, are elementary; they have been accepted and practiced empirically for a few million years since life began on our planet; yet in modern America, we flounder in our productive operations, as hopelessly put back in the running as the hook-worm victim in the South.

What is this insidious disease that wastes our resources of materials, of human potentiality, of equipment—that prevents the application of efficiency principles even as the existence of the hook-worm prevents the application of principles of human well-being?

The industrial hook-worm disease is defective organization.

In the first essay of this series I have shown that a certain type of organization, whether applied to the development of empires or to industrial shops, produces very high efficiency. There is another type of organization, unfortunately the one almost universally adopted in our collective activities, which is incapable of applying efficiency principles; and the use of this type is responsible for much of modern inefficiency and waste. An air compressor, forcing hot and squealing air, and a vacuum pump softly coaxing cooling air, are one and the same machine working on the same cycle in opposite directions. With a few very simple changes the compressor can be changed into the vacuum pump. So with a few very small changes a disastrous form of organization can be turned into a beneficent form. We shall try to make clear the difference between these two forms of organization, to show why it is impossible for one type to apply efficiency principles and impossible for the other type not to apply them, to show that from the beginning of life the efficient type has always produced better results, and that a long step forward towards conservation will have been taken when we adopt for our collective life the superior type; to show that the change from one type to another is radical only in theory, not in operation—not at all such a change as substituting electric traction for steam traction, a prohibitively costly undertaking; much more such a change as substituting a north window with its mellow diffused light for a south window with its fierce glare and shadows.

In primitive times, with that fatuity and perversity which unaccountably characterizes so much that is human, we turned to the left when we ought have turned to the right. Having two forms of organization to choose from—only two, the destructively offensive and the constructively defensive—we chose for our industrial organization the destructively offensive type, and it does not work out, never can and never will; while we ought to have chosen the constructively defensive type of organization, alone suited to productive upbuilding.

The two types of organization are as old as life, are therefore far older than humanity, and we have had to accept them as part of our inheritance just as we accept the necessity of assimilation, of elimination, of reproduction, of breathing. But there is no more reason in adhering industrially to the destructive type of organization, since we have learned that the other is better, than there is in adhering to pack teams and ox carts after the railroad and automobile have been perfected.

To bring out clearly the radical differences between the two types of organization, in spirit, in effectiveness, and in methods, we select two primitive examples, one a plant and the other an animal. The plant trusts to the generous, often enthusiastic co-operation of forces outside of itself and it therefore draws strength of wide and unlimited range. The mammal trusts to the occasional, often grudging, co-operation of powers identical in kind with its own, therefore of limited scope. The pathfinder through primeval forest is impressed with the luxuriant wealth and profusion of plant life—trees, at their best, 400 feet high; is impressed with the comparative paucity, pettiness, transitoriness of animal life, whose largest jungle representative is the elephant, twelve feet high and living at most a few hundred years. Plants trust all nature and draw help from everywhere; animals trust none but their kind and grow through destruction. Even that type of all that is silly and innocent, the sheep, will destroy in a few years a millennial pasture range.

The wild rose bush exemplifies the defensive, upbuilding type of organization. The rose stems are covered with sharp thorns so that the delicate flowers may not be plucked and destroyed by wanton creatures who might just as well be browsing on grass or leaves, but the color and perfume of the blossoms attract the bees, beetles, butterflies, and moths who in return for an efficiency reward, the honey, cross-fertilize the plants. The petals fade and drop, the seed receptacle, an inconspicuous green, swells and grows. When ripe,

the leaves that hid it fall away; it appears red, a tempting rose-apple to bird that plucks it, to mammal that finds it dropped, but the cradle of the seeds is so protected that the rose babies escape to grow and flourish where they fall. The rose relies on defensive up-building organization, calling on water, air, warmth and light, earth, insects, birds and mammals, each taking a part, all helping the rose to dot the western prairies, to deck the roadsides and moors of the New England seaboard, to blanket the lovely North Pacific Coast.

Roosevelt gives us the other picture when he describes the African baboons who are organized for offense, for destruction:

> The baboons were very numerous around this camp, living both among the rocks and in the tree-tops. They are hideous creatures. They ravage the crops and tear open new born lambs to get at the milk inside them; and where the natives are timid and unable to harm them they become wantonly savage and aggressive and attack and even kill women and children. In Uganda, Cuninghame had once been asked by a native chief to come to his village and shoot the baboons, as they had just killed two women, badly bitten several children, and caused such a reign of terror that the village would be abandoned if they were not killed or intimidated. He himself saw the torn and mutilated bodies of the dead women; and he stayed in the village a week, shooting so many baboons that the remainder were thoroughly cowed.

Baboons do not act singly, but in bands with leaders, with sentinels posted. Baboons, wolves, wild dogs and primitive man are thoroughly organized for offense and destruction. It is because the object is offense and destruction that evil characteristics are most prominent—arbitrariness, irresponsible exercise of power, harshness, cruelty, with anarchy all along the line.

Some strong male, differing not in kind but merely in degree from his fellows, has fought his way to the top, is given allegiance, based partly on fear, partly on self-interest. He delegates power, or each lower rank of followers usurp power, and this results in anarchy all along the line. Are we now writing of the African baboons, of the wolf pack, of the paleolithic war chief, of the neolithic hunting, foraging, plundering, filibustering chief, of the enterprising New York Madagascar trader, of the respectable Rhode Island slave and rum trader and privateer; or are we writing of Roosevelt's land and marine experiences as a Rough Rider with our army and navy; or are we writing of the shops of the great industrial incorporations, of the operation and maintenance of our railroads? It is all one and the same thing, as they all are victims of a common

type of organization resting on the same principles—individual arbitrariness at the top, usurped and delegated power down the line, anarchy everywhere.

Modern men have lost the fangs and the cruel hands of the baboon; in them also his savage, cruel instincts are softened. Modern sea captains are not such monsters of cruelty as Henry Morgan, modern generals are not as ruthless as Caesar, Attila, Genghis Khan, Tilly, or even Napoleon. Men, thoroughly good, conservative, upright men, with every great upbuilding instinct, are happily at the head of most of our great institutions; they are infinitely better than the destructive organizations through which they are compelled to work, knowing no other; but the old danger is always latent. We who know could fill volumes with modern illustrations of the ever out-cropping evils due to the destructive type of organization.

Let all who wish to become acquainted with a detailed story of humiliating inefficiency, due to arbitrary incompetence—at the top, mitigated by usurped power and anarchy everywhere, read the appended extracts from Roosevelt's Rough Riders.*

---

* "The battalion chief of a newly raised American regiment, when striving to get into a war which the American people have undertaken with buoyant and light-hearted indifference to detail, has positively unlimited opportunity for the display of 'individual initiative.' . . . . . If such a battalion chief wants to get anything or go anywhere he must do it by exercising every pound of resource, inventiveness, and audacity he possesses. The help, advice, and superintendence he gets from outside will be of the most general, not to say superficial, character. He will have to fight for his rifles and his tents and his clothes. He will have to keep his men healthy largely by the light that nature has given him. When he wishes to embark his regiment, he will have to fight for his railway cars exactly as he fights for his transport when it comes to going across the sea; and on his journey his men will or will not have food, and his horses will or will not have water and hay, and the trains will or will not make connections, in exact correspondence to the energy and success of his own efforts to keep things moving straight.

"It was on Sunday, May 29 at San Antonio, Texas, that we marched out of our hot, windy, dusty camp to take the cars for Tampa. There were no proper facilities for getting the horses on or off the cars, or for feeding or watering them; and there was endless confusion and delay among the railway officials. The railway had promised us a forty-eight hours' trip, but it was four days later that we disembarked, in a perfect welter of confusion. Everything connected with both military and railroad matters was in an almost inextricable tangle. There was no one to meet us or tell us where we were to camp, and no one to issue us food for the first twenty-four hours; while the railroad people unloaded us wherever they pleased, or rather wherever the jam of all kinds of trains rendered it possible. We had to buy the men food out of our own pockets, and to seize wagons in order to get our spare baggage taken to the camping ground which we at last found had been allotted to us. . . . . .

"It was the evening of June 7 when we suddenly received orders that the expedition was to start from Port Tampa, nine miles distant by rail, at daybreak the following morning; and that if we were not aboard our transport by that time we could not go. We had no intention of getting left, and prepared at once for the scramble which was evidently about to take place. As the number and capacity of the transports were known, or ought to have been known, and as the number and size of the regiments to go were also known, the task of allotting each regiment or fraction of a regiment to its proper transport, and arranging that the regiments and the transports should meet in due order on the dock, ought not to have been difficult. However, no arrangements were made in advance; and we were allowed to shove and hustle for ourselves as best we could, on much the same principles that had governed our preparations hitherto.

"We were ordered to be at a certain track with all our baggage at midnight, there to take a train for Port Tampa. At the appointed time we turned up, but the train did not. . . . . .

"We now and then came across a Brigadier-General, or even a Major-General; but nobody knew anything. Some regiments got aboard the trains and some did not. . . . . At six o'clock some coal cars came by and these we seized. By various arguments we

The efficiency engineer meets everywhere the inefficiencies, losses, ravages, disasters, material and moral, always latent, often active in wrong organization. To illustrate by instances from experience:

The able president of a two-hundred-million-dollar corporation, hearing that piece work resulted in greater output than day work, ordered piece rates put in and made the basis of remuneration on a few days' notice. A disastrous strike followed, costing the corporation $2,000,000, the community being made to suffer from violence of all kinds by strikers and their sympathizers, by officials and their hirelings. This president would not have presumed to design a steam engine, perhaps not have presumed without advice to select a typewriter; yet he rashly acted on two of the most delicate problems that confront any modern corporation, *wages* and *efficiency reward*.

---

persuaded the engineer in charge of the train to back us down the nine miles to Port Tampa. . . . . .

"The trains were unloading wherever they happened to be, no attention whatever being paid to the possible position of the transport on which the soldiers were to go. Colonel Wood and I had jumped off and started on a hunt, which soon convinced us that we had our work cut out if we were to get a transport at all. From the highest General down, nobody could tell us where to go to find out what transport we were to have. . . . . The quay was crammed with some ten thousand men, most of whom were working at cross purposes. . . . . .

The military attachés came out to look on—English, German, Russian, French and Japanese.

"We were allotted a transport—the Yucatan. She was out in midstream, so Wood seized a stray launch and boarded her. At the same time I happened to find out that she had previously been allotted to two other regiments—the Second Regular Infantry and the Seventy-first New York Volunteers, which latter regiment alone contained more men than could be put aboard her. Accordingly I ran at full speed to our train; and, leaving a strong guard with the baggage, I double-quicked the rest of the regiment up to the boat, just in time to board her as she came into the quay, and then to hold her against the Second Regulars and the Seventy-first, who had arrived a little too late, being a shade less ready than we were in the matter of individual initiative. There was a good deal of expostulation, but we had possession; and as the ship could not contain half of the men who had been told to go aboard her, the Seventy-first went away as did all but four companies of the Second. . . . . The transport was overloaded, the men being packed like sardines, not only below but upon the decks; so that at night it was only possible to walk about by continually stepping over the bodies of the sleepers. The travel ration which had been issued to the men for the voyage was not sufficient, because the meat was very bad indeed. . . . . The soldiers were issued horrible stuff called 'canned fresh beef.' There was no salt in it. At the best it was stringy and tasteless; at the worst it was nauseating. Not one-fourth of it was ever eaten at all, even when the men became very hungry. There were no facilities for the men to cook anything. There was no ice for them; the water was not good; and they had no fresh meat or fresh vegetables. . . . . .

"By next morning came the news that the order to sail had been countermanded, and that we were to stay where we were for the time being. What this meant none of us could understand. It turned out later to be due to the blunder of a naval officer. . . . . .

"Meanwhile the troop ships, packed tight with their living freight, sweltered in the burning heat of Tampa Harbor. There was nothing whatever for the men to do, space being too cramped for amusement. . . . . So we lay for nearly a week, the vessels swinging around on their anchor chains, while the hot water of the bay flowed to and fro around them and the sun burned overhead. At last, on the evening of June 13, we received the welcome order to start. . . . . We knew not whither we were bound, nor what we were to do. . . . . We had a good deal of trouble with the transports. . . . . One of them was towing a schooner, and another a scow. . . . . .

"We rolled and wallowed in the sea-way, waiting until a decision was reached as to where we should land. On the morning of June 22 the welcome order for landing came.

"We did the landing as we had done everything else—that is, in a scramble, each commander shifting for himself. . . . . There were no facilities for landing, and the fleet did not have a quarter the number of boats it should have had for the purpose. . . . . Meanwhile, from another transport, our horses were being landed, together with the mules, by the simple process of throwing them overboard and letting them swim ashore, if they could. . . . . One of my horses was drowned. The other, little Texas, got ashore all right. While I was superintending the landing at the ruined dock, with Bucky O'Neill, a boatful of colored infantry soldiers capsized, and two of the men went to the bottom; Bucky O'Neill plunging in, in full uniform, to save them, but in vain."—ABBREVIATED FROM ROOSEVELT'S ROUGH RIDERS, Pages 47-71.

He did not know that efficiency reward ought to be preceded by the careful, systematic, and expert application of eleven other principles, of which "Wages" is a minor element of one; he did not know that the eleven anterior principles were largely lacking in application in his company, and that conditions were not ripe for any form of efficiency reward; he did not know that even if his company had been fitted to adopt the principle of efficiency reward, it remained a momentous question as to what form should be used, piece rates being probably the last that a competent expert would recommend. He was not to blame. He had to make a decision, and he did not have an organization around him, over him, under him, that automatically prevented this mistake, equally disastrous to his company, to his employees, and to himself.

The general superintendent of one of the largest American industrial plants, tremendously successful through his great genius, power, ability, told me with pride that for five months he had refused to allow any shop tools or supplies to be bought. He boasted that a smith foreman, failing to secure on requisition flatter steel, had made flatters out of Krupp steel tires which he appropriated for this purpose. The tool account came down, it is true, but at what cost in man-wasted time with smooth files, and all other man-supply deficiencies—in diminished output from machine-wasted time due to defective belts and all other machine-supply deficiencies?

Industrial arbitrariness by the superintendent, delegated and usurped power in the foreman, anarchy all along the line!

There are more disgraceful examples that could be cited in which foremen plundered and swindled the men under them, debauched wives, violated homes, because the power to employ and discharge, to promote and reduce, to augment and to lower compensation, had been delegated to them. American trade unionism, with all its imported tenets of inefficiency, is in large part a justifiable collectivism, alone able to cope with some of the worst outrages to which individual wage earners have been exposed; and it is pathetic that these same wage earners, in resorting to unionism, have known no better than to adopt all the worst characteristics of the very organization against the evils of which they were rebelling.

A high American railroad official of great and long experience told me that no grievance committee of wage earners had ever come to him with what seemed unreasonable and unfair demands that he had not been able to find as the original incentive to their action the arbitrary injustice and tyranny of some insignificant local official, foreman, or boss.

I have intimately watched the inception, progress, and end of three railroad strikes. Twice they were precipitated by the arbitrary action of irresponsible, yet conscientious and able railroad officials. The money lost in these two strikes by the employing companies was sufficient to establish efficiency operation on every American railroad, and under efficiency operation strikes are inconceivable. The third road won its strike hands down because it spent for defense, preparation, and mitigation of evils, one-tenth the sums necessary in the other cases for war and destruction.

In American organization a successful man becomes president, he selects his staff, his cabinet and—he puts it up to them. Each in turn selects his staff of managers and—puts it up to them. The manager selects his superintendents, and passes the power and responsibility on to them. The superintendent selects foremen, and delegates to them the power "to make good." The foremen select their workmen, and transmit to them the power to do the thing the president really wanted done.

The man at the bottom, with the least spare time to plan, the least training, the least compensation, runs the whole affair. This is the type—so usual, so universal, that many will wonder that it is questioned. It is the baboon, the wolf-pack, type of organization and it is all wrong.

The wild rose, relying on allies outside of itself to aid it, has developed and flourished under the defensive up-building type of organization, but we need not go so far afield. Plant life has no monopoly of upbuilding organization. Among the baboons, among the wolves, among the foxes, among men, the defensive, the up-building type of organization also exists, but men have not applied it to business. In his family life, and he is a most worthy husband and father, the fox imposes maternity on his vixen companion. This is no delegation of power, for he is incapable of maternity. He imposes a tremendous responsibility and—he gives the balance of his life to doing his part that she may make a full success of what he imposed on her. He protects, he provides, he feeds her, he watches over her. The organization is one for defense and up-building, and without it life would perish from our planet. The vixen in turn imposes on her young the greater responsibility of life, but in so doing she assumes a crushing burden of obligation towards her offspring. She feeds them from her own body, she watches over them, she trains them and teaches them, and if need be, gives her life for them. She delegated nothing, but she imposed obligation and she gives the

balance of her life that they may make a full success of what she unwittingly imposed on them.

There is of course authority running from top to bottom, authority commensurate with responsibility, greater and stronger authority than that inspired by fear, but though the cubs obey the mother and the father, the organization is one of defense, of up-building.

This is the type of organization von Moltke imposed on a Prussian army. He left apparently intact the predatory form; but he created *staff,* and though it was elementary and inadequate staff it made his stupendous achievements possible. Von Moltke realized that there were natural laws superior to any general orders of his, that the general orders would be effective in exact degree as they utilized natural laws to the best advantage. He therefore created a general staff of specialists, officers, students, experts, acquainted with and skilled in the knowledge of general laws, and it was with their knowledge that he outfitted his armies, planned his campaigns, and executed his designs. The plans of his general staff prevented the issuance of orders contrary to the laws of nature; it stimulated the issuance of orders in accordance with the laws of nature; just as effectually as wheel flanges keep locomotives on the track and as steel rails lessen wheel friction, so there was elimination of futile waste, the promotion of efficiency. It required no revolution, no tearing down of what was to change offense and destructiveness into defense and constructions. Bismarck's main aim was not to conquer Austria or France, but to build up Prussia and Germany, and an army with a new organization was the instrument.

That the race of foxes may endure forever, the vixen exists for the sake of her babies, not they for her; father fox exists for the sake of the vixen and her special task, not she for him.

The stone, spear or sword was distinctly an adjunct to primitive man, but just as distinctly modern man is an adjunct to the machine tool, to the locomotive, to the twelve-inch gun. We would use them automatically if we could, and dispense with the man, even as we now drill oil and gas wells two-thousand feet deep and dispense with a well digger. Having reversed the relation of worker to his tools, we must of necessity reverse the relation of officer to private, of official to employee; we must reverse the administrative cycle. The employee no longer exists merely to aggrandize and extend the personality of the employer, but the latter exists solely to make effective the totally different function of the employee.

Modern industry as distinguished from primitive industry is run

with equipment. It is the locomotive that pulls the train, the car that carries the freight. They are there for this purpose, and this is the inspiration of their design, construction, operation and maintenance.

We would willingly dispense with the locomotive-engineer and fireman if we could; they are capable of something better than watching signals and shoveling coal. The only excuse for putting human beings on such work is that the equipment used still requires human supervision. Similarly, in the shop, the equipment and its purpose are the main considerations and the duty of the machinist is primarily to his equipment. As we rise in the line we find each higher grade legitimately existing solely for the benefit of what is below, not for the amusement of what is above. The foreman is there not to relieve the superintendent of responsibility, but to direct the men on the machines operating to repair the locomotives pulling the freight. The general manager is there for the sake of the superintendents, the vice-presidents are there for the sake of the managers and the president is there for the sake of the vice-presidents.

Ideals may have been imposed or have been conceived by the president—the plan, perhaps, to develop a continent. The instrument used is a corporation, whose efficiency reward is dividends earned by carrying freight and passengers. These ideals of development, of earning capacity, remain; but to carry them out natural laws must be observed, these laws being efficiently taught by those qualified by study and experience to teach and direct. The laws are applied by officials each of whom is servant to the men over whom he has directing control. In vain does president or vice-president, manager, or superintendent issue orders and delegate power under current organization. Knowledge and ability, desire and interest, become diluted with every spreading step.

It is within my knowledge that the able, conscientious, and indefatigable chief engineer of the greatest constructive enterprise the world has ever undertaken was advised that the efficiency was very low, not aggregating much over 50 per cent, and of the remedies. He was offered, free of charge, efficiency staff advice. He did not avail himself of this offer because he belonged to the old school, because he did not know that standards could be established, much less realized, although in sanitation he accepted fundamental organization and authority; and so the actual results under him are costing two hundred million dollars more than they should have cost if he had been von Moltke, if he had had von Moltke's conception of modern organization.

With milions of flowing details, each separately elusive as one among millions of buzzing insects, the task seems hopeless and staggers us by its immensity, until we remember that honey bees, the most independent of union workers, have, as a union, gratefully accepted efficiency administration; that deleterious mosquitoes have been suppressed at the Isthmus of Panama by preventing their birth; that the task of modern organization is to control millions of details through a staff of specialists who supplement each working unit from tool, machine, implement, up to president and to corporation.

The central part in railroading is the locomotive. The one essential for a locomotive is to stay on the track. This is an absolutely modern conception. There was no such idea in the centuries of the pyramids, nor even in the days of Napoleon and of Robert Fulton. Because it is modern, an organization has been created to see that it worked. One might evolve the operation of a modern railroad from the wheel flange. The presidents and their staffs dictate a few letters each day, perhaps a hundred thousand in all; but that rails may stay in place and resist the side pressure of the wheel flange, two-thousand five hundred million spikes are inspected every day by the humble track walker, and though the train runs under the supreme control of conductor, of engineer, of fireman (as much as the dray runs under the control of its driver) the difference lies in the fact that all the departments of track maintenance, of equipment maintenance, and half the operating department, exist solely for the purpose of moving the wheels on top of the rails, of transmitting safely 2,600 horse power through six half-inch squares of frictional contact.

This is a stupendous result empirically achieved, since as yet but little has been standardized as to either truck, motive power, equipment, or operation, and no cost efficiency standards have ever been theoretically established as possible ideals.

The defective wolf-pack type of organization is one in which a chief issues arbitrary orders to his subordinates expecting them some how or other to execute them. The perfected organization for industrial upbuilding and efficiency is one in which specialists formulate the underlying principles, instruct as to their application, and relentlessly reveal both their observance and neglect.

It is of minor importance how the knowledge and experience of specialists is made available for the control and guidance of all line officials. Independent accounting firms impose their checks on even the greatest corporations. Independent efficiency specialists might well impose more profitable and important checks on the greatest

corporations. The same end might be attained of an efficiency engineer, advised by an efficiency board, holding a position of efficiency authority on a president's staff, even as comptrollers hold positions of authority as to accounting.

Accounting, however accurate and minute, cannot of itself bring about efficiency. It tries to evolve a standard by comparison, showing that on some other occasion the record was better, therefore presumably always possible.

No modern business presumes to run without some kind of accounting. This is embryonic recognition of the need of staff regulation. Accounting in all its phases is a minor division of one of the twelve efficiency principles, *trustworthy, immediate and adequate records.* The eleven other principles are none of them less important than records, some of them more important.

A modern undertaking of any kind will be prepared to operate efficiently when it reverses the cycle, when each minute operation can attract to itself all the required knowledge and skill in the universe. It is only through a qualified staff, applying as needed to every detail the twelve principles of efficiency, that the cycle can be practically reversed.

How, practically, should this staff be formed and made effectively operative? No patent medicine exists that is a universal tonic for all forms of debility. No two organizations are alike, either in their merits or in efficiencies, and the object of staff is to provide what is missing, whether in organization, recognition of efficiency principles, or their application.

It is evident that there ought to be a controlling efficiency engineer, even as there is a comptrolling accountant or auditor. The comptroller as to accounts acts as a funnel into which are drawn all the best experience of the world as to accounting, and after filtration it is carried authoritatively down the line and applied where needed. A competent librarian acts as an intermediary between all the knowledge of the universe collected in books, and the great miscellaneous reading public seeking information. An efficiency engineer ought similarly to act as a funnel, being equipped to gather from all available sources whatever is of operating value for the organization he is advising.

Just as it is the business of the comptroller to apply accounting principles, so is it the business of the efficiency engineer to apply to all operations the twelve principles of efficiency. The duty of the executive desiring efficiency, who has accepted the defensive, upbuild-

ing type of organization by appointing an efficiency chief, is not to demand details but to demand a certain efficiency—whether 80, 90, 100 or 110 per cent—and he should make himself sufficiently familiar with the twelve efficiency principles to apprehend their bearing on ultimate efficiency, thus qualifying himself to second and make operative the plans of his expert. If he waives the attainment of any definite excellence, he may set up his own limiting standards as to each of the twelve principles and instruct his efficiency engineer to accomplish what he can under the limitations imposed. Everybody knows that a horse trotting a mile in two minutes can be secured, and that the mile will be trotted in this limit if every condition required for success is provided. On the other hand, a wagon may be loaded with 5,000 pounds, a mile measured over a bad road, and the horse and driver told to do the best they can. They may do well, but it will not be a two-minute performance. In operation, a whole plant—a whole railroad, for instance—can be brought up to the highest practicable efficiency if the principles are applied through a suitable organization. A defective organization and emasculated principles will attain correspondingly lower results, usually equally unsatisfactory to the executive and to his staff assistant.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

IV. ELECTRICAL EQUIPMENT.

Mr. Koester's first article, published in April, was concerned with the impounding of water supplies and the attending engineering construction. His second dealt with head races, pressure pipes and penstocks. In June he took up water-wheels and the mechanical equipment of the power station. The present installment considers the electrical machinery, and in August he will review the transmission and distribution of current. The whole discussion is addressed not to the specialist in hydroelectric engineering, but to those who will value a concise review of the foundational elements in good modern practice—whether as contractors, owners, managers, or financial and commercial associates.—THE EDITORS.

IN modern high-tension power transmission, alternating current is practically exclusively employed, either single-phase, two-phase or three-phase, the last named being generally preferred. Induction, revolving-armature and revolving-field generators are used, and in nearly all cases they are directly coupled, either rigidly or flexibility, to the turbine shaft.

The induction generator derives its name from the projecting ends of the rotating element which are termed inductors. The chief advantage of this type lies in that there is no rotating winding, as both field and armature winding are stationary. The rotating element is simply a mass of iron consisting of a catch spider of two or more parts, and because of this design high peripheral speeds may be obtained. The armature winding usually employed is what is called a concentrated winding, there being only one slot per face per pole. These are usually wound for 2,300 to 6,600 volts and are generally two- or three-phase. The pressure wave of an induction alternator can be made to approach closely a pure sine curve, a factor of great importance in long-distance transmission and also in connection with arc-lamp lighting systems. The efficiency for full and partial load is high; the regulation, however, is as a rule not as close as that of a revolving-field generator.

The armature of the revolving-armature type consists of laminated steel rings mounted on the rim of the wheel and punched in such a way that when assembled the complete armature core is pierced with slots for the reception of the winding. The fields of large alter-

nators are made of two or more pieces, the division being either vertical or horizontal, so that the frame may be removed and the armature winding made accessible. In the revolving-field type, as the name indicates, the field revolves and the armature is stationary. This method of construction facilitates the insulation of the armature winding and requires that field current, instead of the armature current, shall pass through the collector rings and brushes. On account of this the revolving field alternators are especially adapted to high voltage for large current output.

According to the standardization committee of the American Institute of Electrical Engineers, the regulation of an apparatus intended for the generation of a potential, current, speed, etc., varying in a definite manner between full and no load, is to be measured by the maximum variation of potential, current, speed, etc., from the satisfied condition, under such constant conditions of operation as give the required full-load values. The regulation of an alternator is the percentage rise in voltage obtained by throwing off the entire non-inductive full load. The speed and excitation are of course constant. Good machines have a regulation of 6 per cent on non-inductive loads and 8 per cent on inductive loads, with a power factor of 0.85.

Where synchronous machines are connected to the transmission line, close regulation of the generators is very essential. As these machines run in synchronism with the generator, any sudden variation in generator voltage is transmitted to the synchronous apparatus which cannot respond owing to the inertia effect of the rotating element. If the changes are very sudden, the synchronous machine will fall out of step and eventually stop. For slight changes the speed of the synchronous machine will try to keep step with the generator; this action is known as "hunting."

Where the alternator is subject to great fluctuation in voltage an automatic regulator, such as the Tirrell or Thury, facilitates the regulation of the machine; that is, it automatically controls the exciter current to give nearly constant voltage at the generator terminals.

The efficiency of a generator is the ratio of the power output to the power input and is expressed in per cent; the average efficiency is in the neighborhood of 96 per cent, while in the best machines it is as high as 98 per cent.

It is the practice, particularly in plants supplying current for railway purposes, to operate the generators at 50 per cent overload; however, the highest efficiency is usually obtained at 20 to 25 per cent overload and we will find that European manufacturers do not

underrate their machines, and rate them according to the capacities at the highest efficiency.

The most common frequencies used are 25 and 60 and depend chiefly upon the character of the service, the former being used for power purposes and the latter for lighting, as it does away with fluctuation, while it gives much trouble with synchronous machines such as rotary converters; therefore motor-generator sets are best adapted to sub-stations where 60-cycle transmission lines are installed.

In the last few years 15 cycles has been much used for railroading, particularly in connection with single-phase systems, and during the discussion of this subject before the American Institute of Electrical Engineers, in June, 1907, the principal arguments in favor of 15 cycles were given as

1.—An increase of 30 to 40 per cent in the output of a motor of a given size, and consequent reduction in the total number of motors required to operate a railway, and in the cost of equipment.

2.—Better performance of the 15-cycle motors, including higher efficiency, higher power factor, and better commutation.

3.—Less dead weight to be carried on cars and locomotives.

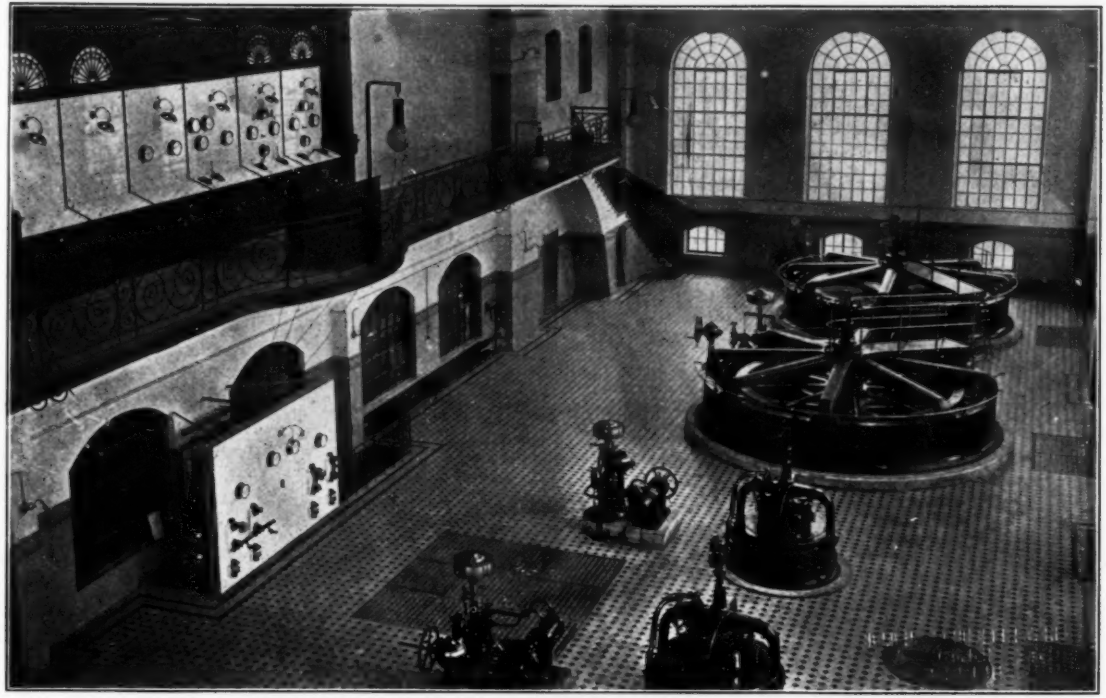
4.—Lower line losses.

For low-tension distribution, voltages of 110, 220, and 440 may be considered as standard. For higher generator voltage, 1,100, 2,200, 3,300, 6,600, 11,000 and 12,000 are most frequently used in American practice.

While American engineers have been discussing the advantages and disadvantages of high-voltage generators feeding directly into a transmission system, it remained for the Continental engineers to design, construct, and operate such machines. Of the several high-voltage generator installations on the Continent of Europe which have been in operation for some years, probably the most prominent one is that at Manojlovac, Dalmatia. Here there are operating four 5,200-kilowatt, 30,000-volt generators directly upon a 21-mile aerial transmission line. Another plant where generators of 5,200 kilowatts and 30,000 volts will be found in equally successful operation is the plant at Subjago of the Anglo-Roman Lighting Co. of Rome, Italy.

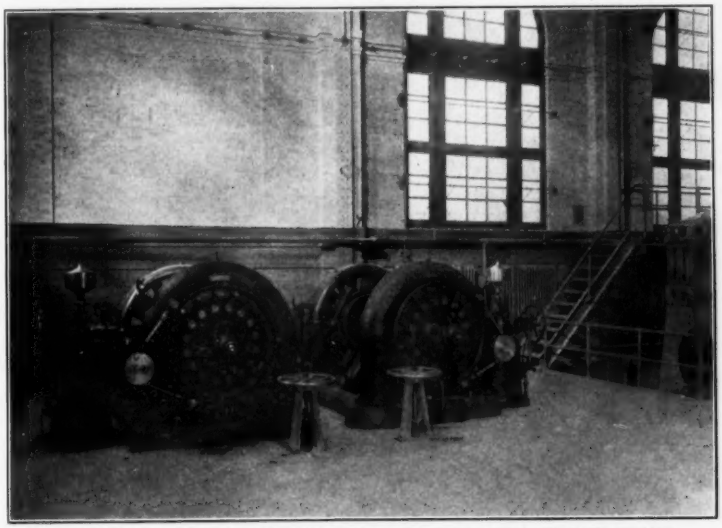
The fear expressed by some engineers as to the possible unreliability of high-voltage generators is consequently without foundation; to entertain such fear would seem to indicate a belief that expensive high-tension transformers are the only reliable protecting devices for generators against lightning. Fortunately, there are numerous other devices for protecting the generators.

6,000 HORSE-POWER TURBINE DIRECT-CONNECTED TO 30,000-VOLT 42-CYCLE THREE-PHASE ALTERNATOR, MANOJLOVAC PLANT, DALMATIA.



GENERATORS, EXCITERS AND SWITCHBOARD, KYKELSRUD, NORWAY.

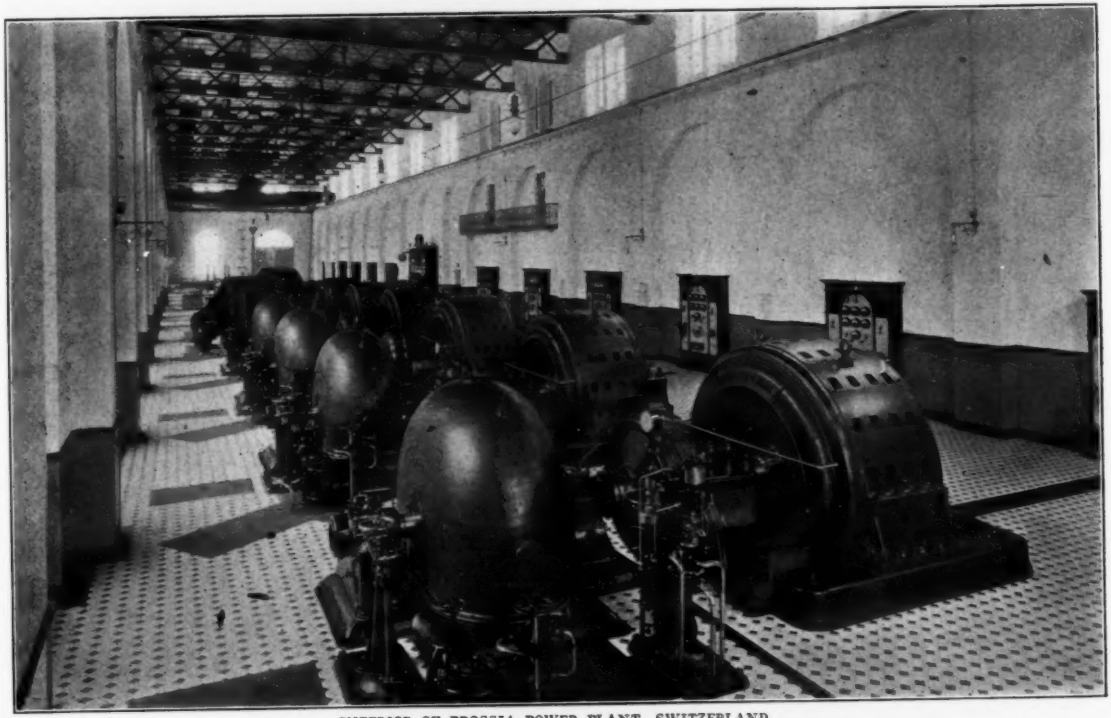
The advantages of high-voltage generator plants lies in the low first cost, low operating expenses, simplicity of station wiring, and better line regulation; transformers and their attendant troubles are eliminated. A 30,000-volt generator is, of course, more expensive than a 6,000-volt or other low-voltage generator. However, taking into consideration the step-up transformers necessary with low-voltage generators, the single cost of a high-voltage generator outfit is lower; further, with the latter equipment the power house is smaller and therefore less expensive. The simplicity in station wiring is at once evident; there is no low-tension bus-bar system, with



150-KILOWATT 125-VOLT TURBINE-DRIVEN EXCITERS, SCHAGHTICOKE PLANT.

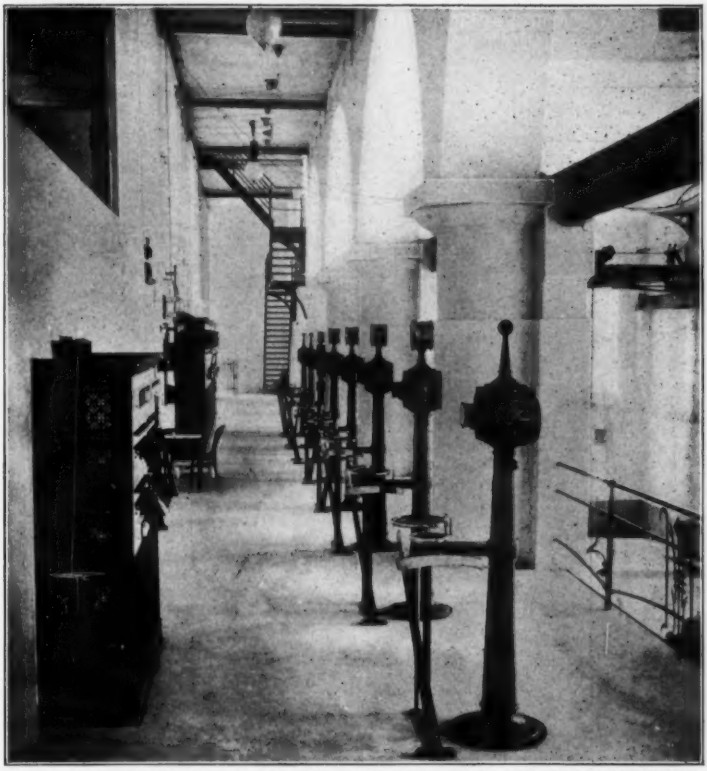
switches, transformer measuring instruments; therefore no special low-tension compartments are necessary. However, better and more expensive instrumental transformers are required. The operating performance of the station is simplified, there being no step-up transformers to look after when the generators are put into service; when the generators are to be run in parallel and thrown on the line, all that is necessary is to bring the incoming machine to synchronism and then throw it onto the bus. The absence of transformers relieves the system of surges attendant upon throwing unloaded transformers onto the busses.

Exciters are driven either by separate turbines, or mounted upon the shaft of the main generator or belted to it. In the two cases



INTERIOR OF BROSSIA POWER PLANT, SWITZERLAND.

last-named the exciter is dependent upon the operation of the main unit, the disadvantage being that in case the speed of the main unit should drop the excitation is diminished, thus necessitating the installation of an automatic regulator.



PEDESTALS FOR GENERATOR INSTRUMENTS, OBERMATT PLANT, LUCERNE, SWITZERLAND.

In connection with the exciters may be installed storage batteries, which float on the exciter busses to take care of fluctuations and peak loads. These storage batteries may simultaneously supply current for lighting the power house in emergency cases, and as frequently the circuit breakers are motor-operated, with remote control, the storage battery comes in handy for this purpose.

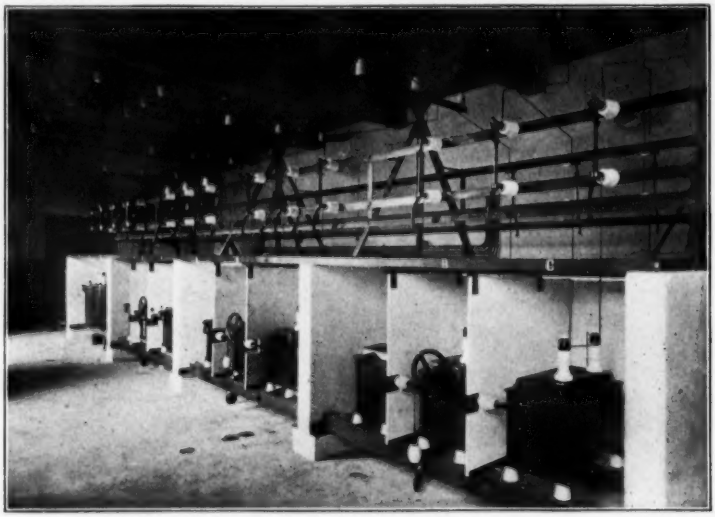
The generator leads to the switching room or switchboards should run as inconspicuously as possible, which result is secured by laying

them either in trenches, tunnels, or in tile or iron conduits. The size of the leads is always specified by the manufacturer.

Switching Room.

The switching rooms are located either in the power house itself or, in connection with large power plants, in a separate building. In such case only the controlling apparatus is located in the power-plant building, while the entire switch gear for the outgoing feeders is in the separate building located some distance away. Good examples of this kind are those of the Ontario Power Co. and the Canadian Niagara Power Co. In the majority of cases, however, the switching room is located alongside of the generator room so that the latter may be readily overlooked from the main switchboard operating gallery.

It is decidedly bad practice to have the whole switchgear located in a single room; it should be separated as to high and low-tension, transformers, etc., either by locating these on separate floors or by partition walls.



33,000-VOLT SWITCHBOARD, LEIZARAN, SPAIN.

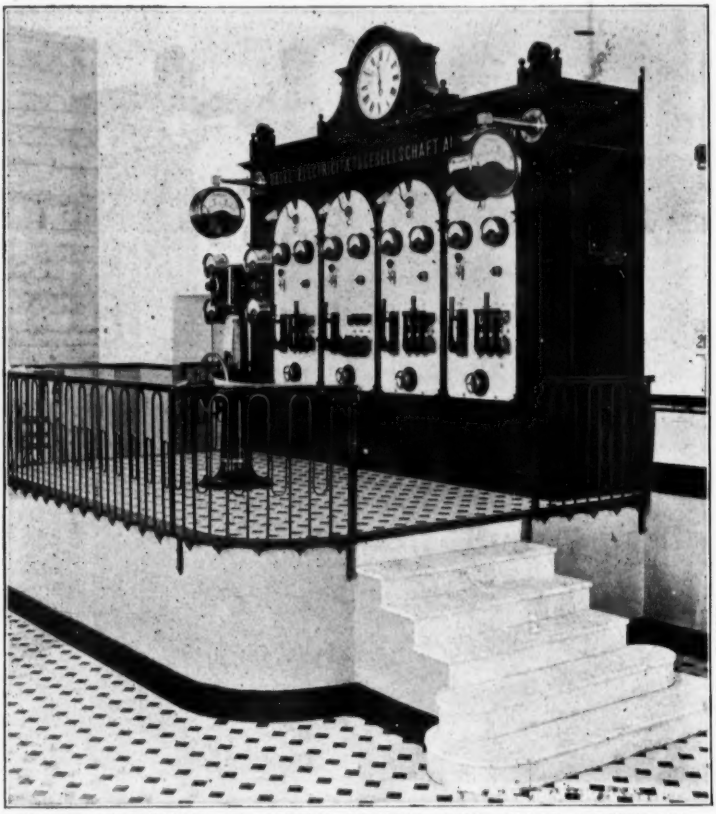
The structure for the switch boards should be fire-proof and so arranged that easy access may be had to all parts to facilitate inspection and repair. The arrangement of the apparatus as well as the whole switchgear upon the panels must be simple and symmetrical to prevent as far as possible the making of wrong connections. The number of instruments and protecting devices must be sufficient to

REAR OF SWITCHBOARD, KYKELSRUD PLANT, NORWAY.

secure a flexible and continuous operation. All live parts, especially those of high potential, must be eliminated from the front of the switchboard.

When laying out a switchboard, either for direct current or alternating current, each generator or machine must have its own panel, and the various panels for the same type of machines should be in separate groups. Provision must be made for further extension.

American and European practice are virtually the same in this direction. However, in the installation of one of the largest hydroelectric plants in Europe, that at Brusio, Switzerland, the direct

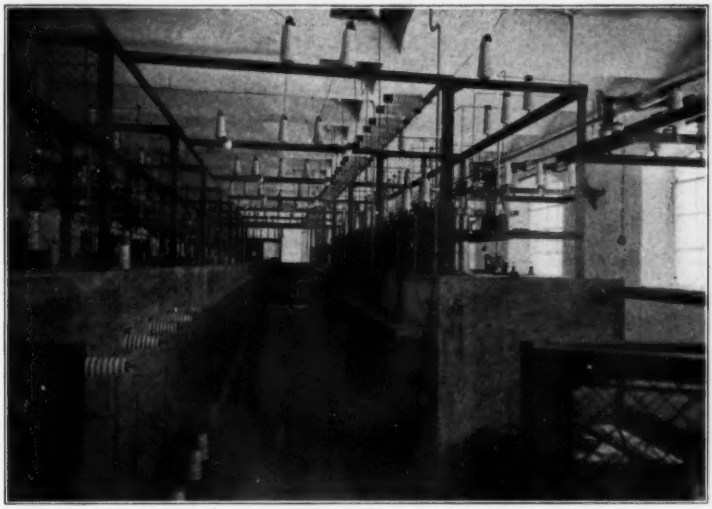


EXCITER SWITCHBOARD AND CONTROL PEDESTAL, BRUSIO PLANT, SWITZERLAND.

central system of switchboards has not been adopted, each generator having its own switchboard just opposite the generator. When the various generators work in parallel they are controlled from a single instrument pedestal in the front of the exciter switchboard in the middle of the generator room. This system was adopted because of the great number of generators installed. The generator attendants of the various machines look after the switchboards while the outgoing feeders, of which there are but few, are controlled from the central instrument pedestal.

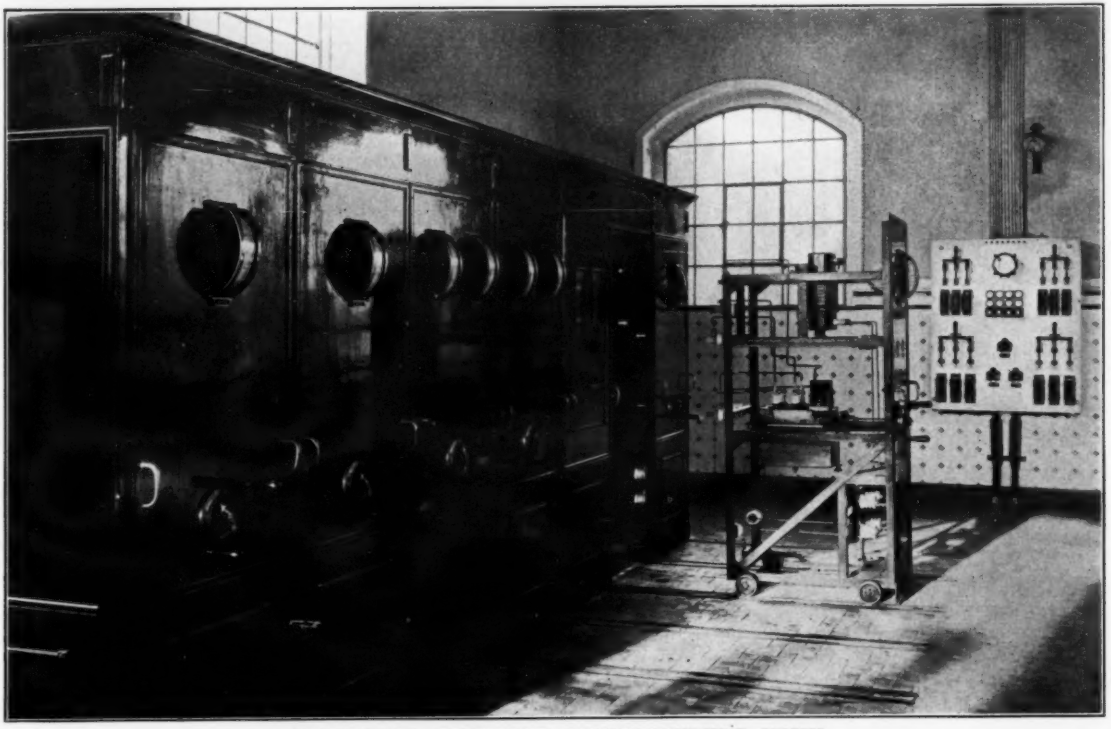
The various types of devices for mounting switches and measuring instruments may be summed up as: the panel board, desk or bench

board, pedestals or columns. For some years several types of "wagon" panels have been in use on the Continent of Europe. These consist of a carriage of structural steel upon which a panel, with the switches and instruments belonging thereto, are mounted; each such panel structure is provided with wheels so that it may be readily pulled away from the remainder of the switchboard, for inspection and repairs. The electrical connections are not disturbed thereby as the end of the panel structure is provided with knife switches so that by means of the heavy clips the circuits are made and broken. Danger of contact with live wires, etc., during inspection and repairs is avoided. This type of apparatus is shown on page 506.



35,000 VOLT SWITCHBOARD, HEIMBACH PLANT, GERMANY.

All power plants, whether small or large, where continuous operation is required, must have a double set of bus-bars or the equivalent, and the generator and outgoing leads to and from the bus-bars must be so provided with switches that current may be thrown on or drawn from either one of the bus-bar systems. An additional safeguard against interruption of service is to insert in each bus-bar system a sectionalizing switch. In high-tension plants where circuit breakers are used, section or hook-switches must be placed on either side of them so that they may be isolated for inspection or repairs. Where transformers are used it is advisable, particularly where there are a number, to have a bus on the outgoing



WAGON PANEL SWITCHBOARD, SIEMENS-SCHUCKERT SYSTEM.

feeder side. In American practice the double bus-bar system for outgoing feeders is seldom found, but will be found to a great extent in Swiss installations in the form of ring systems.

In one of the recent prominent German installations, that of the Heimbach plant, it will be found that there is no low-tension bus between the generators and the step-up transformers. Each 5,000-volt generator feeds through a fuse directly to its transformer. The consequence of this arrangement is that if a transformer is out of commission the particular generator is shut down, and vice versa. The high-tension side is tied together with a single ring bus-bar system, the ends of which are connected through choke coils. Between the transformers and the bus bar automatic circuit breakers are installed, and each outgoing feeder is provided with an automatic circuit breaker, choke coil, and three-pole tie switch. The whole is amply protected by lightning arresters. Considering the protection and particularly the flexibility of the high-tension side, it seems strange that the low-tension side should be so rigidly connected, and this plant may be seriously handicapped when a transformer, a generator, and a turbine of different groups are out of commission, although breakdowns are an unusual thing in Continental installations.

Bus bars are made up of cables or of flat bars of copper or aluminium, and in rare instances copper pipes are used when supports are far apart, as will be found in the Ontario plant. Flat bars, for mechanical reasons, are preferable to round ones as the connections are very readily made. The cross-section area of the bars of long bus bars may be made uniform and additional leaves added as each generator lead is joined to the bus bar, to give the required total area. The size of the bus bar is determined by the number of amperes it has to carry; from 700 to 800 amperes per square inch of copper is usually chosen as a safe value. If aluminium is used the cross-section area must be 1.66 times that of copper for equal electrical conductivity. For electrical reasons, also, the flat bars are to be preferred as they present a greater radiating surface per square inch of cross-section area, thus keeping the resistance, due to heating, from increasing. This is also a reason which favors open bus-bar compartments.

Bus bars are placed either in closed or open compartments of masonry. In closed compartments, openings of about 15 inches square are left and these are provided with iron doors. The open compartments, both for high and low-tension busses, are much in favor in Switzerland and Italy. This is due to the fact that more space is

6,000-VOLT BUS-BAR ROOM, OBERMATT PLANT, LUCERNE, SWITZERLAND.

devoted to the installation of the whole system, and that they prefer to have every high-tension apparatus exposed to view. Of course, wider aisles are therefore necessary. Installations of this kind, of 40,000, 50,000, and even 66,000 volts are found there, the latter being the highest voltage used there at present.

In modern switchboard engineering the most contradicting practice may be found. Oil switches of 600 volts are installed on the back of switchboards, operated by a lever, while on the other hand they are remote-controlled. Again, switches for 10,000 volts are mounted directly on the back of the switchboard; also, with 6,000-volt switches, the oil chambers of the individual phases are placed in large and very expensive masonry cells, the axis of which is well protected by especially designed fireproof doors; furthermore, with 50,000-volt oil

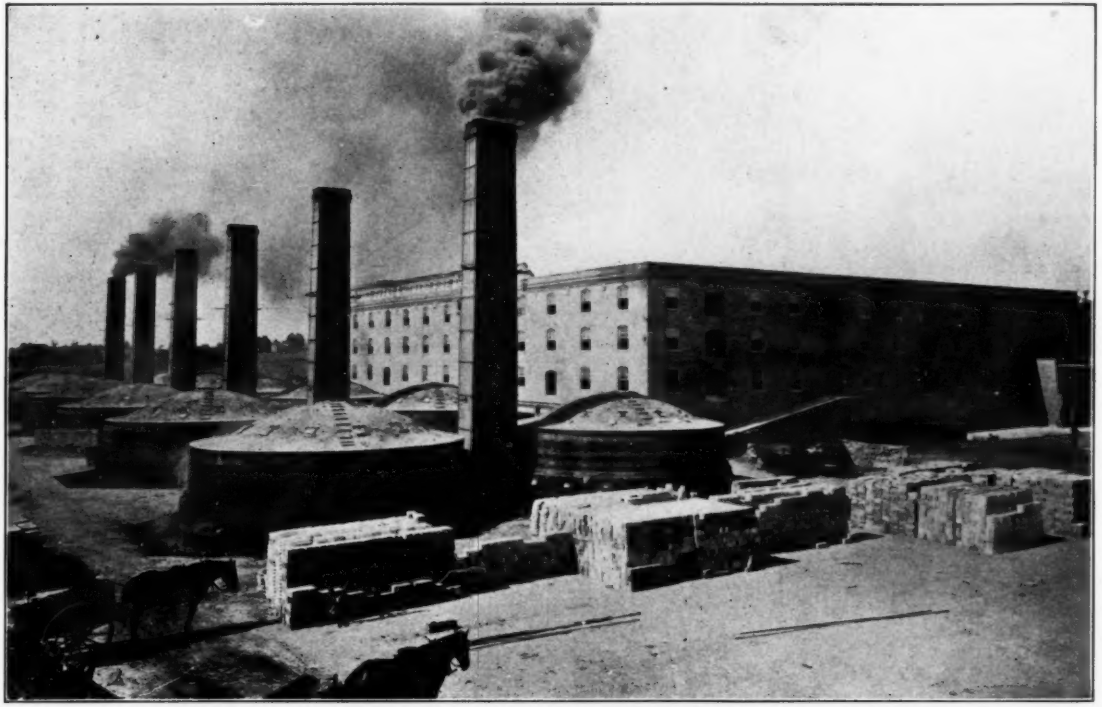
switches, all phases are placed in a single sheet-metal tank, unprotected, and exposed to view. In addition to this the former is operated by a motor or solenoid, the latter by lever and rods. To go still further in citing the difference in practice, there are 60,000- and 80,000-volt circuit breakers in operation which have the phases in separate sheet-steel tanks exposed to view, being entirely unprotected by masonry construction so commonly used with 6,000-volt switches. Even 120,000-volt and 150,000-volt switches of the former type are advocated. From these contradictions in practice it will be observed that arguments as to the danger to the operating force from exposed high-tension apparatus are without reason, particularly if one bears in mind that practice has proven that 220 volts may cause death as readily as 30,000 volts or higher. It is evident from the above that much expenditure in first cost could be saved, also in maintenance and floor space in the design of modern oil switches or circuit breakers.

A high-tension oil circuit breaker is nothing more than an oil switch provided with an automatic opening device. The purpose of the circuit breaker is to protect the generator and transformer from overload, reversal of line current, and excess voltage, for which purpose overload relays, reverse circuit relays, and over-voltage relays are installed.

Overloads in most cases are caused by short circuits on a line; the common practice is to maintain the short circuit and burn it out. There are cases, however, where the short circuit can not be burned out and to maintain it would damage the line. To prevent long and excessive shorts from damaging the line, the circuit breakers are provided with overload relays, which will cause them to open in a certain set time after the short is established.

The reversal of currents is caused chiefly by synchronous apparatus connected to the line, such as synchronous motors and rotary converters. Cases sometimes arise that these machines instead of absorbing power will pump it back, and when this happens there is usually trouble, especially if there are underground conduits in the system. To prevent any damage from this source, the power-house circuit-breakers are provided with reverse-current relays, which cause the circuit breaker to open upon reversal of live current.

The over-voltage relay causes the breaker to open upon excess of normal voltage, due to over excitation or poor line regulation. The former difficulty is under the control of the operator, while the latter is under the control of the designing engineer and can be avoided.



GREGG WORKS OF THE EVENS & HOWARD FIREBRICK COMPANY, SHOWING TEN OF THE KILNS.
Suggesting the improvements in fuel economy that are possible at all firebrick works.

STRIPPING AND MINING, UPPER CLAY BANKS OF THE DIDIER-MARCH COMPANY.

THE MINING AND FABRICATION OF FIRECLAY.

By A. S. B. Little.

Mr. Little's artice is prepared and published for the chief purpose of turning the attention of engineers and manufacturers to unrealized opportunities for profitable improvement in a great industry.—THE EDITORS.

IF it were not for fireclay, engineering activities would be something like building operations without any foundation. If one gives the subject even a slight amount of consideration, it is obvious there is no single mineral which is of so much importance to engineering practice and progress as is this somewhat slighted "mud." The "mud man," as the manufacturer of fireclay products is called, is considered about equal in prominence and respect to the "hewer of wood and drawer of water," largely because people take his products without questioning why they are what they are, or how they could be replaced by any other mineral or combination of materials.

As a suggestion of the universality of the functions of fireclay, we might consider how a railroad train could be run from Chicago to New York in eighteen hours if the locomotive firebox were not lined with fireclay slabs.

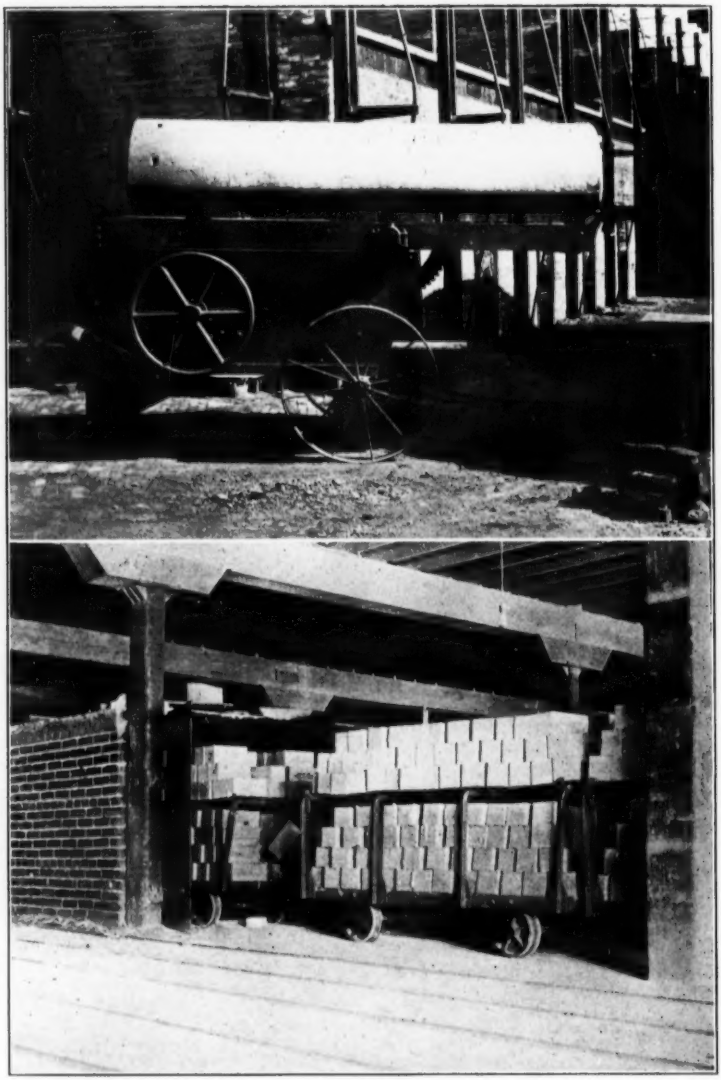
This clay has been in use for centuries, and yet I believe the industry is one which lacks definite laws more than any other, including those which are either modern, or ancient and of less prominence. You can go to a manufacturer of steel and specify what you want by actual figures or statements, and you can check the product by chemical analysis or mechanical tests and thus make sure you get what you need. The producer knows how to combine certain elements, and what quantities of various kinds to combine, in order to get a result at least very closely approaching what you call for; but not so in the fireclay business. It is not entirely or evenly principally the fault of the fabricator or of the skilled employees in the trade, as to my knowledge on many occasions great efforts have been made both here and abroad to acquire definite knowledge of the nature of fireclay and its behavior under certain conditions. In America the Federal authorities have taken up the matter; in England a society has been formed amongst users and producers, and in Germany every sort of concentrated effort is being made, all with the idea of product

ONE OF THE TWO MINES, GREGG WORKS OF THE EVENS & HOWARD FIREBRICK COMPANY.
Depth of seams, 75 ft.; thickness, 6 to 8 ft.; roof, 12 to 18 in. coal, and part shale and slate.

SPECIAL CALCINING KILN FOR REMOVING IMPURITIES FROM "FLINT" CLAY, EVENS & HOWARD COMPANY.
Note open coal-fire holes, and resultant waste of heat.

betterment. There is therefore every inducement for engineers to discuss the subject and give help where it is so much needed.

In the past, the most skilled and highest salaried chemists have been employed to make tests, to promote and carry thorough investigations on the natural product, and to study the workings of certain manufactured and elaborated articles derived therefrom. The result has been, generally speaking, confusion worse confounded. Two professors, working at similar times on brick or clay, obtained from the same source and manufactured under exactly equal conditions, have recorded diametrically opposed conclusions! The same scientist at different periods has reached vastly varying conclusions when testing identical qualities and shapes of bricks; so can you wonder if a prominent fireclay manufacturer should exclaim, as I heard one on an occasion after having the above experience, "All tests of fireclay are

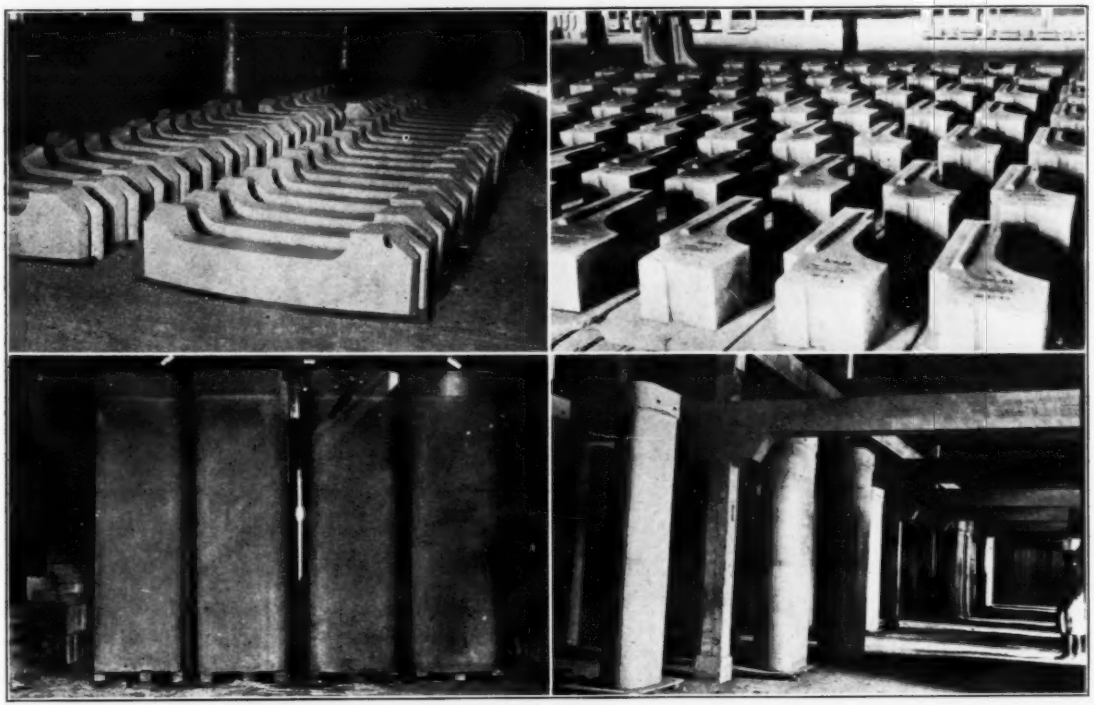


TRANSPORTATION OF MATERIALS AT THE GREGG WORKS.
Above, taking a retort from kiln to railway car. It has been burned three weeks at 2,700 degrees F. Size, 16 by 28 in. by 9 ft. 3 in. Below, trucks of bricks and dobies emerging from tunnel, where they have been drying in waste heat from one of the kilns.

empirical, and I would sooner trust our superintendent to pick and select his clays in the old fashioned way, than pay a high fee for a highbrow's recommendations." The chief method of testing fireclay by a practical man is literally to *eat it*. He can detect grit and sand best by that method, and a good fireclay, (free from silica, quartzite or flint clay) is free from grit. His only other personal test is by experiment.

It must be said, however, that the factory methods usually found in use at fireclay plants are lacking in those labor-, fuel-, and time-saving methods which are considered essential to success in every other modern up-to-date industrial concern. Also in the mixing departments, in the grading of the different sizes and kinds of clay and "grog," the element of guesswork is too much in evidence. The various dry pans are each worked separately, (at different times they are varied in their duty), on one of four or five classes of clay, and the various grades are then taken by chain and bucket elevators, and thence by belt conveyor to several overhead bins as described hereafter. No attempt is made to weigh or measure accurately the several kinds or sizes of clay or grog which it has been predetermined shall form a mixture for a brick or tile required to do a certain specified work. Also, beyond the elevator and conveyor from the mills to the storage bins, hardly any use of mechanically operated transport appliances is even attempted. The mills and pans are fed from wagons or barrows or both, all loaded and wheeled and dumped by hand and at the sweet will of a "Polock" or "Dago" as the cheap rough foreign laborer is called.

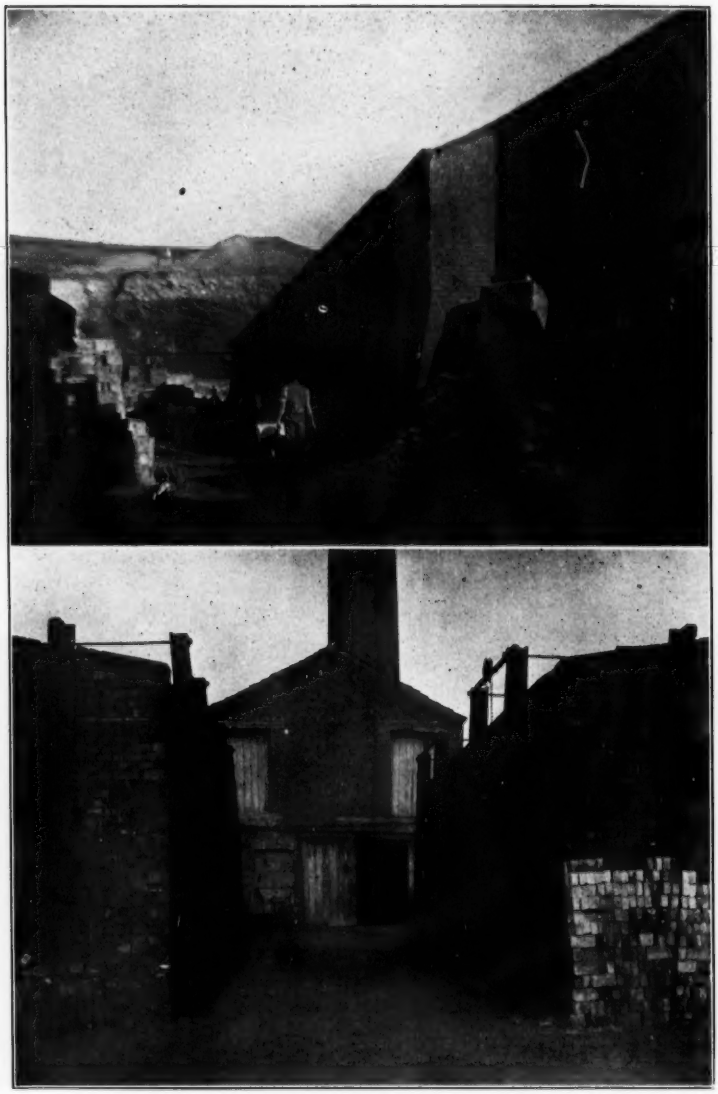
Then again, to see the way raw solid fuel is thrown on open fireplaces leading to circular or oblong kilns is enough to resurrect the immortal William Siemens. Coal is thrown out of coal cars, somewhere near a kiln *if possible*. It is hauled in wheelbarrows to (say) twelve fireholes in each kiln, and there may be forty kilns on a yard, each kiln approximately 24 to 30 feet diameter. Each fire is separately fired by hand, is hand-clinkered, and the ashes are handled in barrows when convenient and contain 10 per cent of combustible matter. The green bricks are handled by man power, on trucks, to the dryers, and are then carted in barrows to the kiln where they are hand stacked. After three days "smoking," two days firing and two days, (or more) cooling, (using about 1,400 to 1,600 pounds of coal per thousand brick) the burned brick or tiles are unstacked by hand, loaded on barrows, and placed by hand in railroad cars, or sometimes in the stock pile.



REFRACTORY PRODUCTS IN PROCESS OF MANUFACTURE AT THE GREGG & HOWARD WORKS OF THE EVENS & HOWARD FIRE BRICK COMPANY.

Locomotive tile.
Retorts in kiln.
Quartzite tile
Coal-gas retorts drying.

STOCK SHEDS AND SHIPPING PLATFORM, WORKS OF THE EVENS & HOWARD FIREBRICK COMPANY, ST. LOUIS, MISSOURI.
Showing the opportunities for economy by the installation of mechanical-transport appliances.

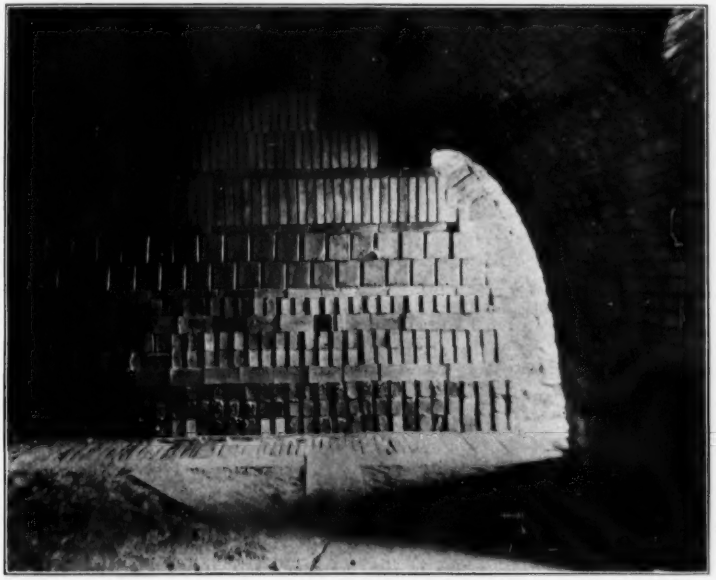


KILNS AT THE CINDER HILLS FIRECLAY WORKS OF JOSEPH MORTON, LTD., HALIFAX, ENGLAND.

The upper view shows the outside of the continuous kiln. The lower shows up-and-down-draught kilns of the old type.

It is with the object of securing the attention of some active and skilled engineer in a contemplative mood that the following general description of a fireclay factory is given. As in many other instances, the best help may be forthcoming from outside the trade. It is badly needed.

As Missouri contains perhaps the greatest producing district in the world, of clays which have never been surpassed in quality, let us select one of the factories there for our viewpoint, the choice falling on one of the most modern as well as the largest.



INTERIOR OF CONTINUOUS KILN, SHOWING METHOD OF SETTING BRICKS AND BLOCKS. CINDER HILLS FIRECLAY WORKS.

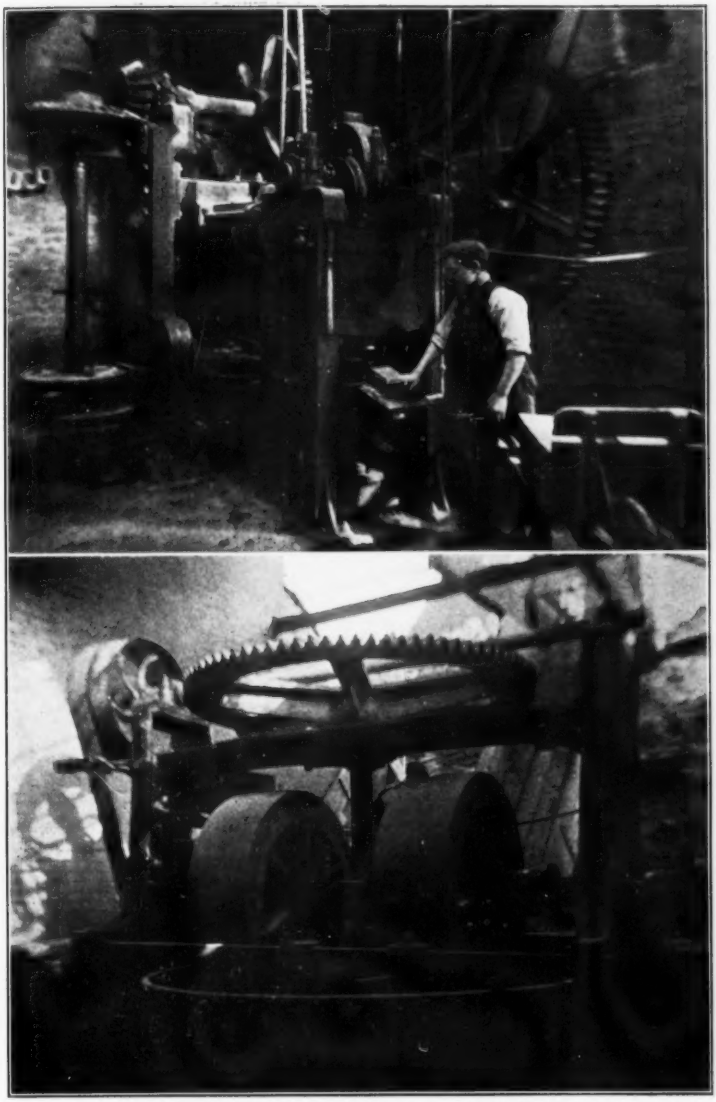
The selection of fireclays for different purposes has always been partly guesswork or rule-of-thumb, and even now in most works too much reliance seems to be placed solely on previous experience with certain beds or banks of clay. To this perhaps is due the fact that a manufacturer may go on for years supplying fireclay goods which have given wonderfully good results, and then suddenly there is a long string of complaints, generated through failure of the brick or tiles which may be made from what appears to be identical quality of clay, manufactured in the same machines, and with the same class of labor. In the language of the trade, a maker is then said to have "struck a bad seam of clay."

Excuses may be genuine but they do not make it any easier for the power producer to keep up steam when his Stirling or Babcock & Wilcox arch falls in.

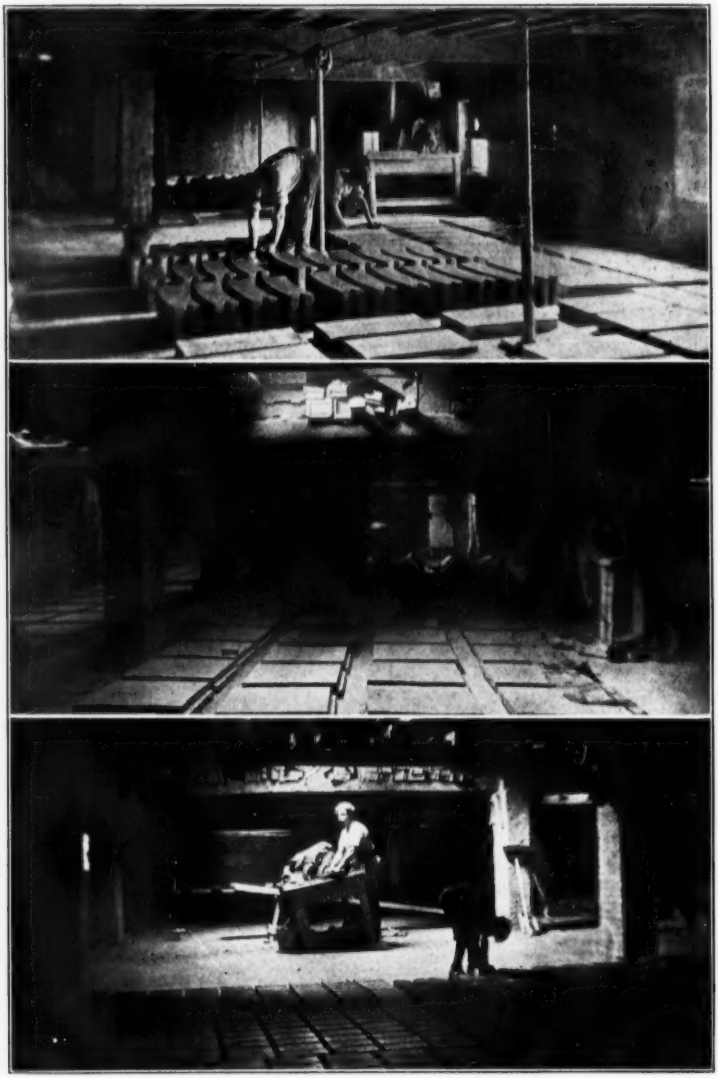
It is only fair to the manufacturer to say that users do not fully comprehend the risk they incur in ordering from the lowest bidder; and this, more than anything else, has tended to reduce the desire of up-to-date manufacturers to incur additional outlay for the purpose of being able to sell brick and tile on a specification basis. All the tests ever made on fireclay goods can result beneficially only if it is clearly demonstrated that manufacturers can find a market for the high-class and chemically correct grades of brick and tile. High price and long life would mean low cost. If the findings of such new kind of reliable tests show the need of better conductivity, increase in resistance to destruction by heat, and the ability to resist abrasion and destruction through mechanical friction or heat variation, then there might be found a means of getting makers to put forth their skill and experience, or to pay for that of others, besides laying out money to get the desired results. The firebrick business has a number of men who appreciate the desire for firebrick betterment, but the capitalists behind them have to be shown the business end of the proposition before permission can be obtained to carry out modern methods. This is hard on the idealists, but it is a straight business argument, and no company can afford to make perfect material unless the demand is there on a paying basis. This phase of the question should be carefully studied. When we consider, however, that in steel plants magnesite or chrome brick at $130 a thousand are now used in certain places where formerly a $25-a-thousand brick was used, there seems some hope of getting users to pay, say, $35 where they now pay $20 for other classes of fireclay or silica brick work.

The best known and most widely used Missouri clay is the Cheltenham plastic brand, although it is not the most refractory. It forms the base of nearly every class of firebrick, excepting only the all-flint brand, being composed chemically as follows:

Silica	46.48 per cent
Fe. Oxide	1.05 "
Alumina	33.52 "
Lime	.33 "
MgO	.28 "
Moisture	4.20 "
Volatile Matter and Combined Water	12.88 "
Alkalies	1.04 "
Titanium	.19 "



ABOVE, A BRICK MACHINE; BELOW, A GRINDING MILL. CINDER HILLS FIRECLAY WORKS.



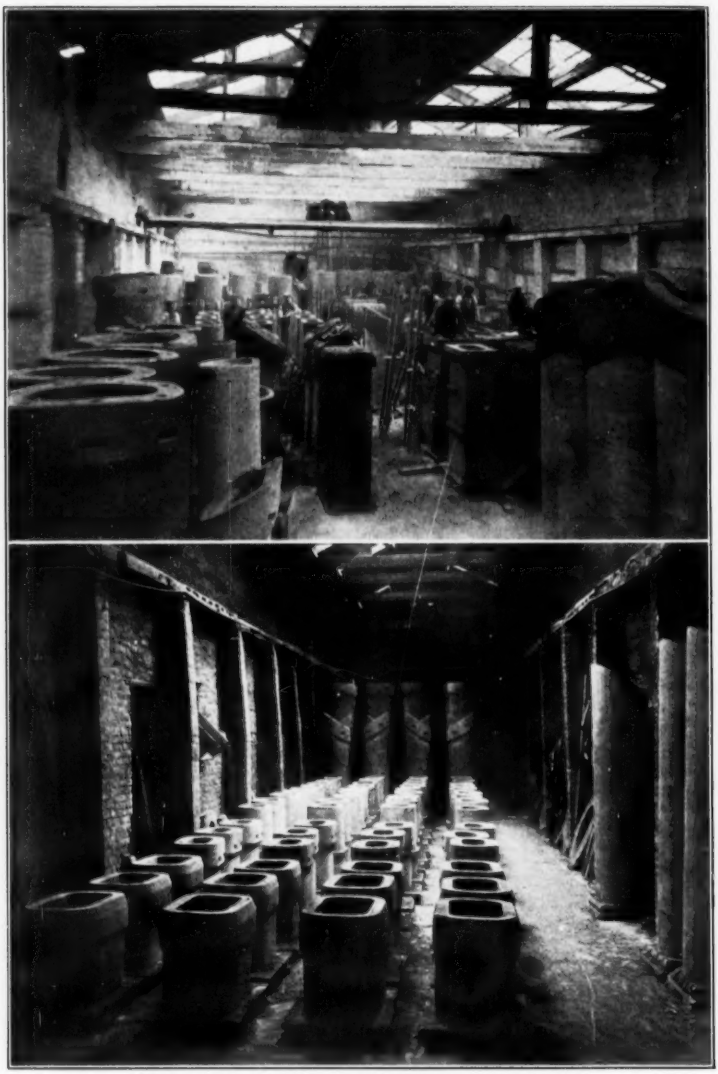
THE MANUFACTURE OF FIRECLAY PRODUCTS AT THE CINDER HILLS FIRECLAY WORKS.
Three views in the drying sheds, showing the moulding of bricks by hand.

Most of the impurities are removed by weathering before the clay enters into brick form. This clay is usually mined at a depth of a little more than 85 feet, and it has to be blasted, which means that precautions have to be taken in the mine for storing powder, the arrangement being generally to build an arched roof and fire-brick sidewalls underground, closing one end with a fireproof door, the other being blank.

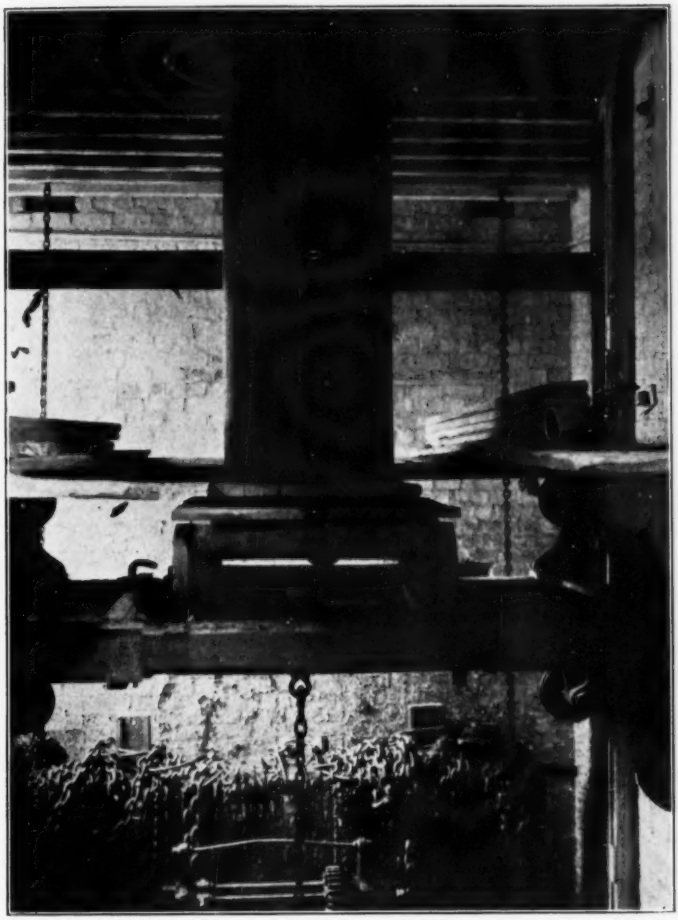
The seams vary in thickness from 8 to 12 feet, and the roof is generally slate with sometimes a poor grade of coal perhaps 6 to 18 inches thick.

In arranging to "win" or mine the clay, several methods are adopted. The correct way is to employ competent surveyors and transit men, who lay out the work on paper and by stakes, so that not only is the clay gotten out to the best advantage, but an accurate record is kept of all cleared portions. The mine is laid out in what are called "entries" and "crosscuts." Timber has to be employed to preserve the passage-way and make it safe for working. When a crosscut is made, the miners are then set to dig out what is called a "room," this being the clay portion between two crosscuts, and measuring about 60 feet square. After the clay is taken out a distancet of 10 feet, timber props are put in to hold up the roof temporarily, and it is somewhat fearsome to a stranger to hear these props creaking as the roof settles. In some places this settling takes place quickly. It is not uncommon to see the props sinking into the undersoil when this is soft. If it is hard, the props will mushroom, top and bottom, or bulge and gradually splinter, and by that time there is no further need to hold the roof up. The clay thus dug out is picked, more or less, underground, the selected portions consisting of pot clay, (a plastic clay covered with a "roof" of poorer clay) being placed in different tubs. These tubs are then hauled underground by mules, driven by a boy who occupies an insecure position on a chain between two tubs, his body being sideways to the travel of the wagon tubs, and his foothold on the connecting chains. The mules maintain a fast trot through the aisles, which are comparatively dark.

The tub wagons are elevated from the mine in a balanced cage, and on reaching the surface, part of them are sent to the weathering bank and then to the factory for the manufacture of cheaper class of brick. The best clay is taken by the wagons and dumped by a jib crane into bins, from which it gravitates into large wagons which in turn take it to the weathering bank or a special calcining kiln.



THE RETORT SHEDS, CINDER HILLS FIRECLAY WORKS.
Two views in the drying sheds, showing horizontal, inclined, and vertical retorts in process of manufacture.



A RETORT MACHINE, SHOWING A RETORT IN PROCESS OF MAKING. CINDER HILLS FIRECLAY WORKS.

For the very best work the "pot" clay is picked by hand before going to the bins.

Other grades of clay are mined in similar ways to those described herein; but flint clay, which is of the highest quality, although sometimes found at the bottom of the plastic clay seams, in most cases is found near the surface in a different district. A few of the Missouri flint-clay mines have outcrops, and in other cases about 6

feet of top soil has to be removed. Holes are drilled and a blast is made, after which the clay is removed. It is very refractory and is most suitable for high heats where there is not much abrasion. For instance, it is not suitable for the lower part of a furnace, where clinkering tools are in use, as it is not tough enough to withstand this severe work; and flint clay becomes semi-plastic under high heats if subjected to pressure. Any attempt to make a denser or tougher brick, by adding a foreign element to act as a bond for the flint-clay particles, seems to destroy the character of the clay. Part of the raw flint clay is placed in a special calcining furnace (shown in one of the photographs), and it is most interesting to examine the partly burned raw clay after it is removed from the furnace or kiln. It very much resembles pop-corn, which name is sometimes applied to it.

The crude flint clay shows the following chemical analysis in some of the best mines:

Water	13.98 per cent
Silica	44.75 "
Alumina	36.37 "
Fe. Oxide	1.12 "
Lime	.00 "
MgO	.07 "
Alkalies	3.71 "

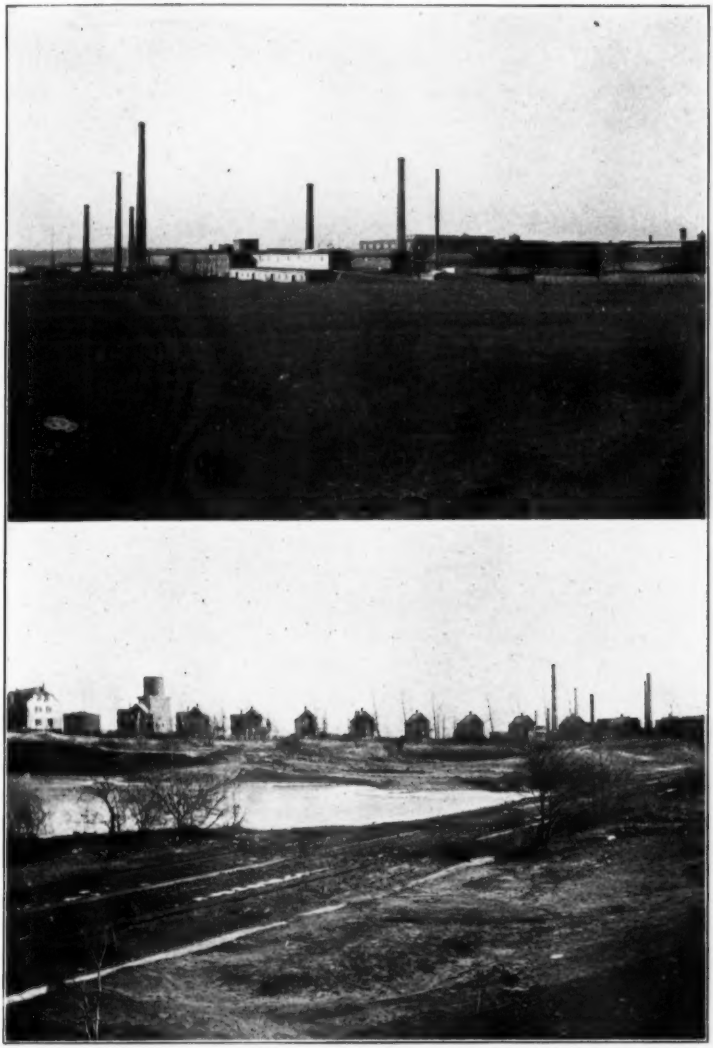
All the impurities are removed in the calcining process.

There is another very high-grade clay obtained from the Missouri mines and used mostly for the best glass-works practice, hence the name, "pot clay." It has the following chemical analysis in its crude unpicked state:

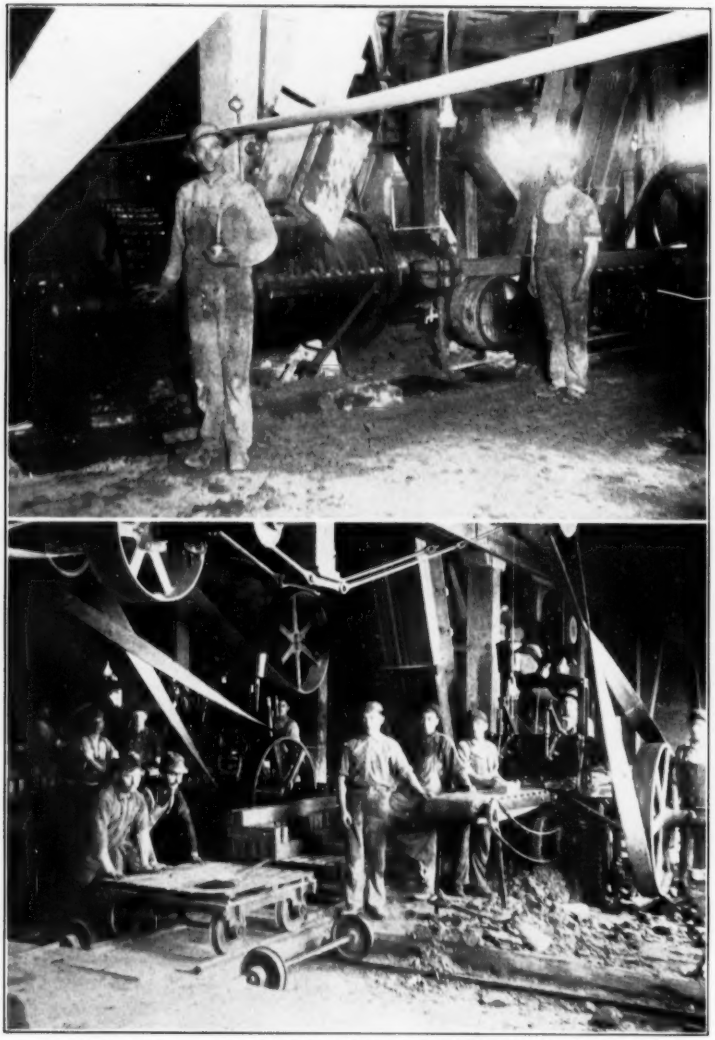
Water	11.02 per cent
Silica	57.53 "
Alumina	28.60 "
Fe. Oxide	1.74 "
Lime	.00 "
MgO	.54 "
Alkalies	.57 "

It is a plastic clay, similar to the Cheltenham, but of much higher grade.

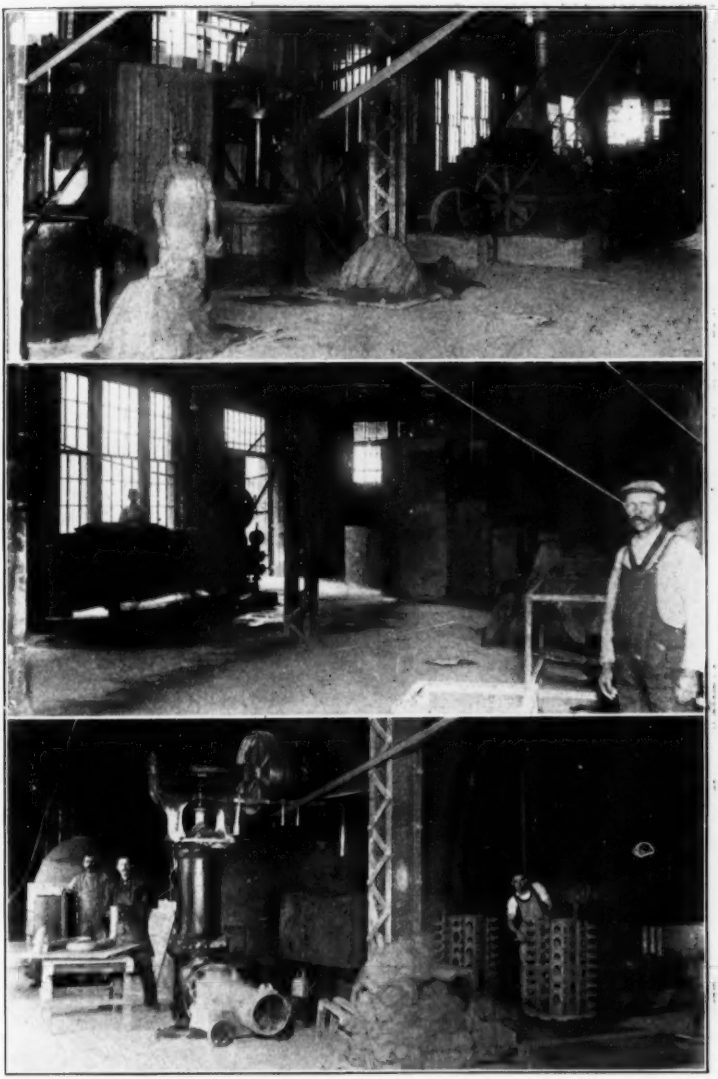
To give some idea of the machinery required in a clay works, we may say a plant making about 700 tons of shapes equivalent to 200,000 9-inch brick a day needs about 650 horse power to run the various machines. A usual arrangement on a works of this size is four dry pans, four wet pans, a cracker, and a Blake crusher. All



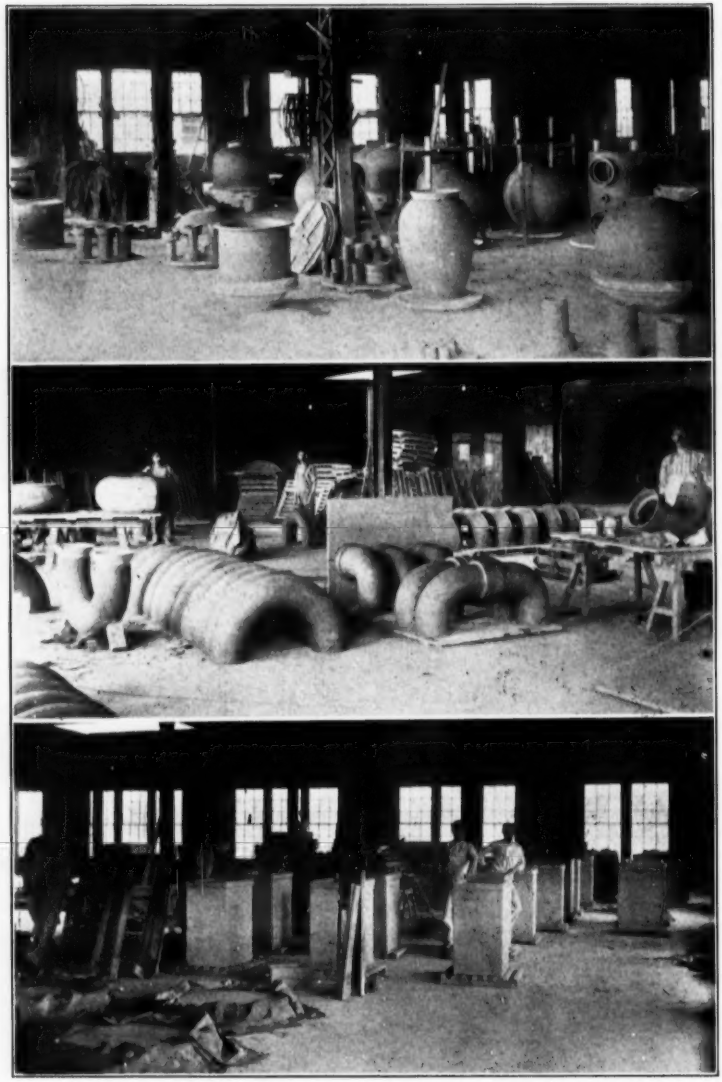
ABOVE, FIREBRICK AND STONEWARE DEPARTMENTS, KEASBEY WORKS OF THE DIDIER-MARCH COMPANY, NEAR PERTH AMBOY, NEW JERSEY. BELOW, THEIR COTTAGES AND INDUSTRIAL SETTLEMENT.



BRICK MAKING AT THE KEASBEY WORKS OF THE DIDIER-MARCH COMPANY.
Above, brick machine and bar of clay issuing from the die. Below, cutting bricks and transporting them to the steam repress. Thence they are taken to the waste-heat dryer for thorough drying before calcination in the kilns.



PROCESSES IN THE MANUFACTURE OF REFRACTORIES AT THE KEASBEY WORKS.
The upper two pictures show portions of the clay-preparing rooms. The bottom one is a corner of the stoneware building, where complicated coils for acid condensation are made.



VARIOUS DEPARTMENTS OF THE KEASBEY WORKS, AND THEIR PRODUCT.
At the top, the manufacture of small apparatus—jars, receivers, etc.: in the middle, the manufacture of pipes and bends; at the bottom, the tank room.

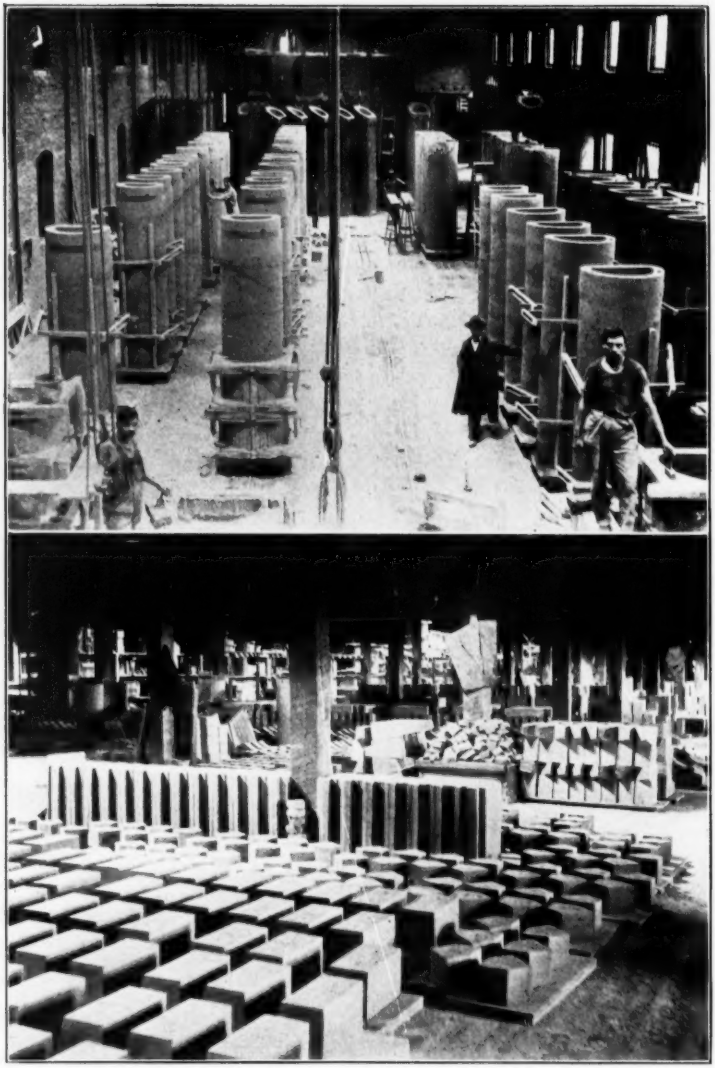
the clay from each dry pan is elevated in continuous buckets to the sixth floor, where it passes over very elaborate and effective traveling screens, the fine material dropping to the fourth floor and the rejected pieces passing back to the pan mill. The screenings fall onto one of two belt conveyors and are dumped automatically into large storage bins, situated over the wet pans. The mixed grades, of which there are about eight, pass through to the wet pans. For high-grade hand-made work the wet clay is taken by trucks on an elevator to any of the four operating floors where it is dumped on tables adjacent to the molding boxes.

Wherever possible it is advisable to use brick instead of tiles or blocks, but in erecting them only hammered work should be allowed. Thick joints cause more than 50 per cent of the failures in furnaces.

All tiles are thrown into molds by hand. It is not difficult to make necessary allowances in the molds to take up shrinkage of clay in air-drying and burning, so long as tiles are flat or of simple shape and have only one average thickness; but it is almost impossible to make blocks (other than flat or simple ones) so that a maker can guarantee the finished article to be like the blue-print. Having the desire to make the blocks accurate in shape and measurement, the maker never burns them in the kiln at high enough temperature or over a sufficiently long time. The consequence is a green core. If the blocks are hard burned, they twist and lose their shape, and even then there is a core which has not had all the shrinkage taken out of it.

In making bricks, part of the mixed grog and clay is sent through the wet pans and on to an auger machine which squeezes out a solid mass of plastic clay 9 inches by 4½ inches wide. It then goes on a band conveyor over a machine where a most ingenious contrivance cuts off about twenty brick at one time, while the clay is passing through it. The brick shapes, in somewhat rough form, are then removed by a band conveyor running in front of a dozen brick "re-presses," and four tile-making machines.

After coming from the re-press machine, the bricks are loaded onto cars which travel on rails along in front of the machines, and by means of turntables the cars are transferred to rails running through the brick tunnel dryers. These dryers are built of concrete and firebrick, in stacks of four flues each, and there are five stacks each 150 feet long. The heat is furnished from the kilns, where by means of dampers the hot air is diverted to tunnels and forced into the twenty dryers. An exhaust fan with a variable speed draws



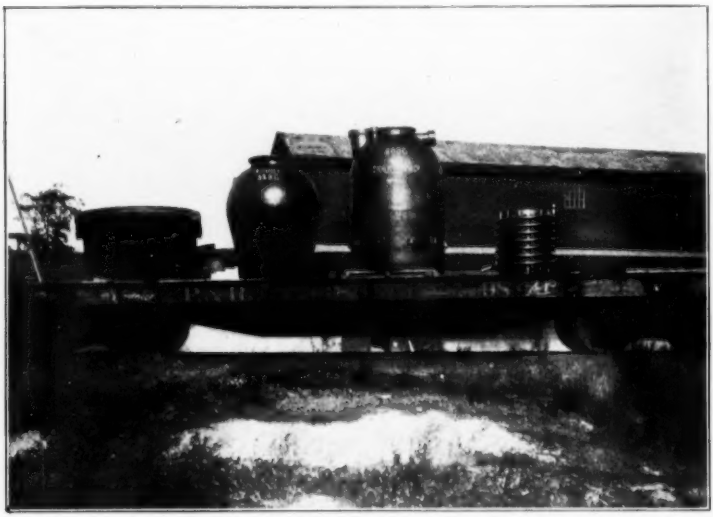
RETORT SHOP AND A PORTION OF THE MOULDING ROOM, KEASBEY WORKS.
The retorts, above, are for horizontal, vertical and inclined coal-carbonizing benches, some very long inclined retorts being seen at the extreme back. The intricate shapes moulded by hand are suggested by the lower view.

away the hot air as desired, in order to maintain equal and sufficient temperature. No heat is taken from the kilns which are under coal fire, consequently the heating medium for the dryers is always clean and free from sulphur or other deleterious chemicals. The tunnel dryers end towards the kilns, and from there the bricks are stacked ready for burning, which takes about a week altogether. All this work is done by hand labor.

Tiles and blocks cannot be hardened in the tunnel dryers. It is a fine art to "bone-dry" some kinds of tiles without cracking and distorting them, and a very thorough system of inspection must be arranged in a clay works where there may be at times all classes, thicknesses and shapes of tiles covering drying floors averaging 142,000 square feet. These tiles, especially those with holes in the body, and particularly where the corners are square, will crack very easily, generally at the corners. It is necessary to patch around the corners at times with loose damp clay. At other times wet cloths are spread over them.

Some tiles are designed by furnace builders in shapes that cannot be placed on the floor in such a position that their own weight will not collapse them. Sometimes ten blocks are made up so as to try and be sure of one good one. It is not unusual out of ten or so to get only five safely into the kiln, and then in burning four more are wasted. It is easy to figure out that such waste is very expensive, as all the labor and coal for ten tiles is expended, and only one tile or block obtained fit for use. These causes are responsible for expense in making tiles. They show why it is difficult to make tiles at any price, and indicate how advisable it is to cut out the tiles and use brick wherever possible. If a block or tile were better when finally put in use, there might be some excuse for adopting it instead of brick. Actually the reverse is the case, so there is all the more need for wonder that some people prefer the block and tile design to the brick. Bricks cost about $5 per ton. Tile costs $9 to $18. Brick can be set up cheaper. They are more reliable. We can only surmise that blocks are so extensively used because they look well on paper. It must be understood that tiles or blocks of even thickness, simple shape, and approximately brick shape and size, are easily made.

The photographs accompanying this article are representative of three large establishments, one British, one characteristic of the Western United States, and one near the American Atlantic seaboard, but of German parentage.



THREE OF THE LARGEST MONOLITHIC PIECES OF CHEMICAL STONEWARE EVER ATTEMPTED IN AMERICA.
Ready for shipment from the Keasbey Works of the Didier-March Company.

The British establishment is that of Joseph Morton, Ltd., Cinder Hills Fire Clay Works, Halifax, turning out a diversified product, including gas retorts, furnace linings, boiler seatings, blocks and tiles, silica bricks, and special forms. The second named, the works of Evens & Howard, are situated at Clayton, about ten miles from St. Louis. The capacity of their No. 3 plant is 200,000 brick a day; their No. 2 plant has a capacity of about 150,000 brick a day, but handles chiefly special work including gas retorts, chrome and magnesite brick, sewer pipe, etc. The third plant illustrated is the Keasbey plant of the Didier-March Co., near Perth Amboy, N. J. It is typical of the few establishments referred to above as being carried on by strictly scientific methods. Its two distinct departments are engaged respectively with refractory clay products and chemical stoneware. The former, which is most closely related to the present topic, comprises many branches of manufacture, from common brick to the most intricate blocks and special shapes. The laboratory in this plant performs a most important function in the process of manufacture.

METAL-WORKING PLANTS AND THEIR MACHINE-TOOL EQUIPMENT.

By Charles Day.

II. BUILDINGS FOR HEAVY AND GENERAL MACHINE WORK.

In two articles under this title, the first of which appeared last month, Mr. Day analyzes the machine-tool equipment of metal-working plants—not in detail, but in general character as influencing especially the design, layout and structural features of the buildings. The first part covered the general classification and the characteristics of general metal-manufacturing establishment. The present section considers heavy and general machine-tool shops. Mr. Day's general classification of metal-working plants into these three classes will be found on page 365 of THE ENGINEERING MAGAZINE for June, 1910.—THE EDITORS.

HAVING covered the principal requirements imposed by metal-working businesses that can be conducted upon a manufacturing basis, we will proceed to consider in the same manner the second class of shops, viz.: those that build given lines of reasonably heavy machinery.

M (2) a—MATERIALS—Usually comparatively heavy, quite diversified and bulky, so making the solution of handling and storing methods more difficult than for shops in the first class, although reasonably fixed conditions are presented.

The stores departments of certain concerns whose output would rightly fall in this class can be laid out with very great precision, because of the accuracy of their knowledge concerning the quantities of materials that should be available. There are other cases where no attempt is made to carry a considerable supply of finished product. The raw materials with which we are now more particularly concerned tend toward large and bulky parts, requiring for their handling and transportation special provision in the form of equipment, and often building features. It was pointed out that for plants coming within the first group the materials entering into the manufacture usually do not influence in any way the buildings proper. In this case, however, we find that the nature of the materials may necessitate floors designed for extraordinary loads, larger door and elevator openings than would ordinarily be required, owing to the nature of the materials, etc.

M (2) b—EQUIPMENT—Generally stock machine tools, adapted to a considerable range of work as compared with the wholly special equipment characteristic of the first class.

The class of work now in question is not sufficiently repetitive to justify the expense of special equipment, so the machine tools that are usually needed are the familiar types of engine lathes, boring mills, planers, drill presses, etc. They are designed particularly with a view to handling a diversified line of work, although the tendency within recent years has been more and more to narrow down their range. Each type is suited to the performance of certain operations, which may be required in connection with the machining of a great multiplicity of different parts entering into products used for widely diversified purposes. Therefore, this group of metal-working plants affords the engineer considerable opportunity for the performance of valuable service in connection with the selection of machine tools. This is the case because the problem is one of *selecting* the standard machines best suited to the performance of the various kinds of work, considered individually and collectively, rather than the task of designing special machines or auxiliary equipment for special operations which is presented by shops of the first class. The engineer who has had the necessary experience can perform the first function quite promptly, whereas the designing of special apparatus, even when the work is performed by experts, almost always requires an amount of time that is not available when planning a new shop.

M (2) c—BUILDINGS—Special to suit the size of the work performed in them and incorporating structural features that are used in the same sense as equipment.

The buildings for plants coming within the class in question must, as a rule, be designed with a view to meeting the special requirements imposed by the product. Overhead traveling cranes are often necessary, and insofar as the building structures are used to support the crane runways, etc., they contribute directly to the equipment of the plant. High head room is usually required under traveling cranes in order to allow of the erection of large machinery, and the heavy floor loads imposed, even in the machine departments, often necessitate special provision.

M (2) d—LABOR—A predominating part properly experienced in respective trades, not merely skilled in the attendance of machines performing single operations.

As stock machine tools adapted to a considerable range of work are used in plants doing the kind of work that we have under consideration, it is necessary to employ comparatively highly skilled operators. The fewer the parts that are handled, and in general the greater their bulk and weight, the higher must be the grade of the

operators—assuming, of course, that a considerable amount of machine or other kind of work must be done upon the parts. Therefore, in shops where large steam engines are made we find that the average competency of the various workers ranks much higher than is the case in a plant making typewriters, although the intricacy of the latter product is much greater than that of the former. While this question of the character of the labor may not materially affect the physical features of the plant, yet it is one that must be thoroughly appreciated in planning a new property or an extension to an existing property.

M (2) c—ADMINISTRATION—Conditions as to materials and equipment and functions of employees are not capable of standardization in the sense that is practicable in shops of the first class, so that intelligent direction of the work requires the constant application of scientific methods based upon elemental understanding of all factors involved and applied through carefully devised system.

When complex conditions are encountered in connection with the planning of an industrial plant, it is certain that equally complex problems will arise in connection with the administration of the work to be performed when the plant is finished.

Owing to the fact that the greater part of the equipment is suited to the performance of a considerable range of work, and also because the number of parts of a given kind may be comparatively limited, it is frequently necessary to perform certain operations on quite a number of different pieces upon the same machines. For example, there may be forty or fifty parts entering into a complete engine lathe that require turning operations. Possibly at least 50 per cent of these parts should be turned upon engine lathes of the same size and type, yet a very small number of these lathes would be sufficient for the entire diversified output. Here we find a state of affairs quite different from that presented by the first class of shops, where a majority of the machines are operated continually upon identically the same work.

As machines are not automatic, there are usually a number of different methods by which given operations can be performed, but only one of these represents maximum economy. Different kinds of work present variations in materials, diameters, and amount of material to be removed, so that speeds and feeds must be adjusted to the particular requirements; and as continuous operation is seldom possible, it is necessary to make these adjustments very frequently. In fact, changes in speeds and feeds and changes of cutting tools are often necessary for the performance of a single job. Consequently,

the efficiency with which machines operate depends upon the degree to which conditions representing maximum economy are maintained.

The various operations upon different parts of the product do not necessarily have to be performed in a given sequence, although one sequence represents maximum economy. From the standpoint of the arrangement of the equipment to accord with the most desirable plan of routing, it is clear that it becomes imperative to establish the sequence in which the more important operations should be performed. Usually there are conditions, arising either from the character of the equipment that is available or the work to be done, making one schedule of operations more desirable than all others.

In view of the foregoing, it follows that the amount and arrangement of equipment must be based upon the assumption that a certain definite system of operation is to be enforced. It is not sufficient for the engineer to decide merely that the operations shall be performed in a certain sequence and the machines always adjusted for conditions representing maximum output, for he may be basing his layout upon a system of shop management that the personnel will be wholly incapable of enforcing. The question of shop management is so extremely subtle and comprehensive that it is not usually practicable for the engineer to attempt to bring about radical changes in the methods employed by those for whom he is designing a new plant, unless the requisite time is available and the engineer's principals have a thorough realization of just what the work is likely to involve.

There are, of course, certain details that are affected directly by the system of shop management that is adopted—for example, the character and location of shop offices, entrances and exits for employees, etc. In addition to providing for such matters, the engineer should aim to lay out the plant so that it will lend itself efficiently to the system of administration he approves even though the older methods must be continued for some time.

The problem of laying out plants coming within this group is much more subtle than in plants of the manufacturing type. The provision of buildings and equipment, worked out in accordance with certain fixed assumptions, does not assure, during subsequent operation, the fulfillment of these assumptions because the physical layout does not indicate necessarily the desired plan of routing. It will lend itself to many less efficint but workable alternate plans, and the same is even more true of the performance of individual machines. It is particularly important that this condition should be recognized by

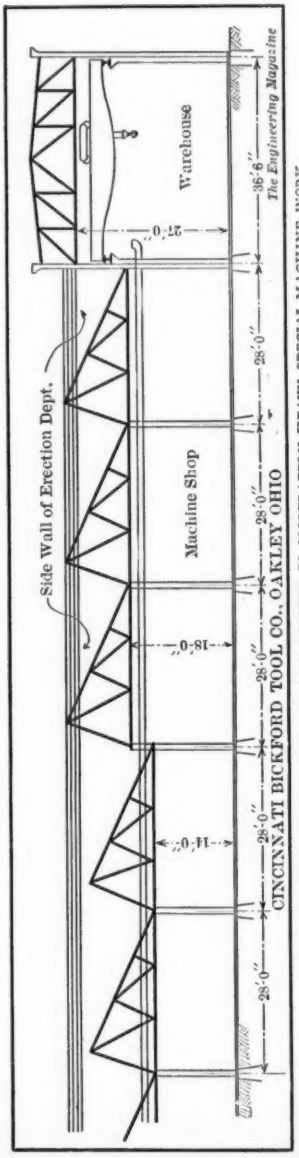
those who will operate the property. It is an inherent fact that while such a layout as we are considering should prove, in the hands of experienced men familiar with its purpose, to be fully as efficient as anticipated, in the hands of others it will probably fall far short of the requirements.

M (2) A, B, C, D, E—RÉSUMÉ.

Owing to the great number of variable factors entering into the problem of laying out plants for heavy machine work of a given line, requiring, among other things, the establishment of certain assumptions concerning the manner in which the work will be handled after the plant is built, it is evident that the selection of equipment both as to character and amount cannot be accomplished with anything like the certainty that is possible for the manufacturing plant. Further, the character of the building is directly dependent upon conclusions reached concerning the equipment, and as these very conclusions are, to a certain extent, only an approximation, it will be seen that unless the best of judgment is exercised, the most favorable solution in regard to the buildings proper will not be obtained.

The routing problem in shops of the second class is much more difficult of solution than in the first instance, and it is much more difficult to comply with the adopted plan than for manufacturing plants. In the first place, when laying out the shop, one cannot expect to secure uniform progress of materials through the plant and the result must necessarily be a compromise with a view to securing the best average routing of all the parts. In certain cases, it becomes necessary to consider carefully the advisability of installing additional equipment, rather than transporting the parts a considerable distance to points where equipment of the desired character is available. In such instances the handling cost must be weighed against the interest and depreciation charges incurred through installing additional machinery for convenience only.

A re-arrangement of departments for the purpose of increasing deficient areas or changing the plan of routing can be effected quite readily, as a rule, in a manufacturing plant where the buildings are of uniform cross section and the equipment can be readily moved. Rearrangements of this kind, however, cannot be made with anything like the same facility or efficiency in the plant composed of various buildings designed for specific kinds of work. Therefore, we are confronted with the anomalous condition that for plants in which the requirements can be definitely anticipated, subsequent changes in departmental locations and areas are not likely to be necessary, although



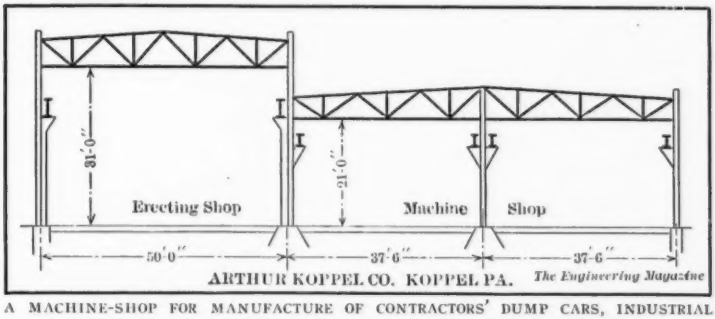
A TYPICAL CONSTRUCTION FOR A PLANT DEVOTED TO MODERATELY HEAVY SPECIAL MACHINE WORK.
A high bay for the warehouse department, one perpendicular to it for erecting large equipment, and large saw-tooth roofed area for machining departments.

they can readily be made; whereas for plants in which the requirements cannot be so definitely ascertained, and the need of subsequent changes is thus more probable, the buildings must be specially designed to comply with radically different kinds of work, which, of course, makes a re-arrangement very difficult to accomplish.

The buildings illustrated on pages 540, 541, 542 and (in part) 546 are occupied by kinds of work that come within the second division of the classification; and it will be clear at once that the designs of the structures have been directly influenced by the character of work performed within them. Not only are the types of the various buildings quite different, but they also represent a wide range in cross-section dimensions. The total floor space provided in the shop of the Emerson Steam Pump Company, Alexandria, Va.,* is about equally divided between the area served by an electrically operated crane requiring a relatively high headroom, and an area or areas over which light cranes can be run but where the head room is such as to lend itself properly to the installation of overhead line shafting. The requirements imposed by the work performed in the machine and transformer departments of the Wagner Electric & Mfg. Company, St. Louis,* were such that the areas under the high bays

These buildings are shown on page 546.

needed to be only one-third of the total floor space, so that the conditions were fulfilled by designing gallery shops as illustrated by the cross-sections. In both these shops the gallery construction possesses industrial advantages in addition to requiring only two-thirds the amount of real estate that would be occupied if the shops were single story throughout.



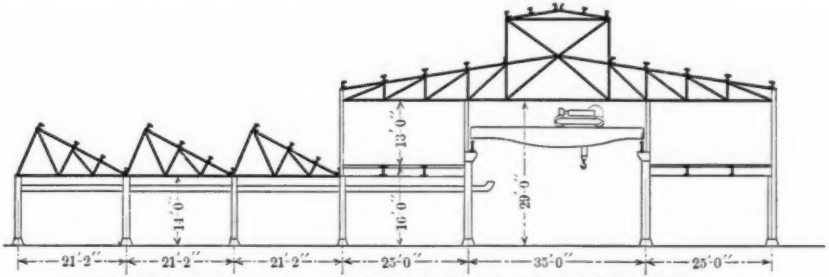
A MACHINE-SHOP FOR MANUFACTURE OF CONTRACTORS' DUMP CARS, INDUSTRIAL RAILWAYS, ETC. SPECIAL WORK OF MODERATELY HEAVY CHARACTER.

Frequently, the area in connection with which relatively high headroom is required is only a small part of the total necessary enclosed space. The main buildings of the new plant now being constructed for the Cincinnati-Bickford Tool Company, Oakley, Ohio, are shown in cross-section on page 540. It will be seen that a high bay is provided for the warehouse department, and one running perpendicular will house the large equipment. The machining departments will be housed in a large area covered by a saw-tooth roof construction, two distinct clear heights being provided to accommodate different kinds of work. A cross-section of two of the shops above, composing the plant of the Arthur Koppel Company, Koppel, Pa., illustrates the manner in which provision was made for the building of their output, which consists of contractors' dump cars, industrial railways, etc. The machine shop now being designed for Barnard & Leas Mfg. Company, Moline, Ill. (page 542) is another interesting illustration of the manner in which certain special requirements have been fulfilled, and the proposed boiler shop of the Ames Iron Works, Oswego, New York, is another.

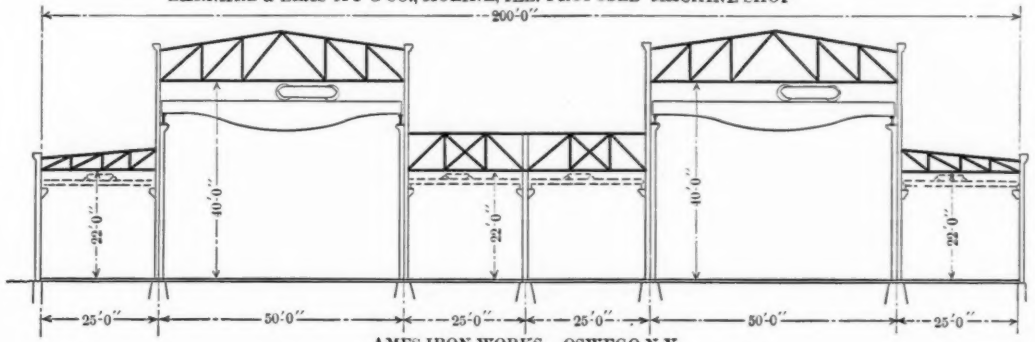
General Machine Work.

We will now take under consideration the broad requirements imposed by metal-working plants that compose the third division of our classification.

M (3) a—Materials—The character and amount of materials can be anticipated only in small part, owing to uncertainty of kind of work



BARNARD & LEAS M'F'G CO., MOLINE, ILL. PROPOSED MACHINE SHOP



AMES IRON WORKS., OSWEGO N.Y.
PROPOSED BOILER SHOP.

PLANTS ILLUSTRATIVE OF ADAPTATION TO SPECIAL REQUIREMENTS OF MODERATELY HEAVY MACHINERY BUILDING.

that will be done. Consequently, there is imposed a wide demand upon the receiving and stores departments.

The repair departments that must be operated by certain large industrial companies come within the group of plants now under consideration. The requirements that must be met in such cases are defined, of course, more clearly than is true for businesses that depend entirely upon jobbing work, but their administration is more difficult in one sense than in the latter case, because extraordinary demands upon the repair department are likely to develop when least expected. If the shop in question is the one set aside for making repairs upon the equipment of a large rolling mill, there will be performed certain routine work comprising the making of parts that must be regularly renewed, turning of new rolls, building of special auxiliary equipment, etc., but the department must also be so equipped and administered that it can handle expeditiously extraordinary repairs of practically any kind demanded by the business.

The raw-materials stores room for a shop of this kind usually contains two distinct classes of materials, namely, those provided for specific purposes such as duplicate machine parts, and various materials which can be used in connection with a variety of needs constituting the daily requirements of the shop. Each commission of this kind presents wholly special conditions, which it is quite impossible to define broadly with anything like the precision applying to the stores of manufacturing plants. In the latter instance the raw material is characterized by large quantities of comparatively small parts, for the storage of which very efficient means can be provided. In contrast with this condition, the materials that must be available in the stores room serving the repair shop are usually of the most diversified character. In certain cases, we find one, or at the most two or three, duplicate parts of very large size and weight, more duplicate parts of smaller size, and a comparatively complete line of miscellaneous supplies, there being, however, but a comparatively small stock of any one article or material. The large parts may absolutely necessitate the provision of special means for handling and transportation, but the bulk of the materials are such as can be handled readily without such assistance. When conditions are as outlined, the stores department can be laid out, however, with somewhat greater precision than is possible in connection with a shop that does purely jobbing work.

The very nature of the jobbing plant is such as to prohibit a close definition of either present or future requirements. The purpose in view is to prepare for as diversified a line of performance as is pos-

sible, but insofar as raw-material departments are concerned it is practicable to carry a permanent stock of only those materials that can be adapted to various uses. Provision must be made, however, for anticipated requirements imposed by the handling and temporary storing of the special materials that given orders are likely to cover.

M (3) b—EQUIPMENT—Principally stock machines suited to very wide range of work. Occasionally special machinery for possible repairs on special parts. Selection of types and determination of amount of equipment can be approximated only.

The ability to perform almost any conceivable job is usually the first requisite when selecting machinery. Therefore, the greater part of the equipment required for job and repair shops consists in standard machine tools, designed with a view to the performance of very wide ranges of work. If this plan is not followed a greater amount of equipment will have to be installed, part of which will stand idle a considerable portion of the time, thus imposing a heavy burden upon the business or department. Wide range of usefulness is usually accompanied by lower efficiency of performance, the efficiency being higher as the design of the machine aims towards singleness of purpose, and becoming a maximum in the full automatic types. However, it frequently pays to secure a wide range of usefulness even at the expense of efficiency, for the ability to perform a given job may be the vital factor, whereas the cost incurred may be secondary only. The lathe equipped with a two-spindle head stock and the boring mill that can be increased in capacity by moving the housings back are extreme examples. In actual practice many other procedures are of course resorted to for the purpose of accomplishing certain work, which procedures would not be considered good practice in plants of the second group. Instances are the use of a planer or slotter where a milling machine would do the work more cheaply, or the use of a milling machine in place of a gear cutter, or the performance by hand of certain operations that under other circumstances could be done more economically by machine. Consequently it is evident that the selection of machine-tool equipment for repair or jobbing shops is a matter in connection with which many questions other than efficiency of machinery must be taken into account.

Repair shops may impose more specific conditions, as for example in the case of a shop serving a large rolling mill, where it may be imperative to provide certain equipment that is designed particularly with a view to making repairs on large parts of the equipment, the breaking of which may be a remote possibility but so vital, if it does occur, that it is justifiable to have available at all times the means

necessary to effect the repairs. Then, again, there is the equipment required to turn the rolls and do other single-purpose routine work.

M (3) c—BUILDINGS—The character of work to be done is usually a governing factor in their design. Precise definition of types and sizes is, however, seldom practicable.

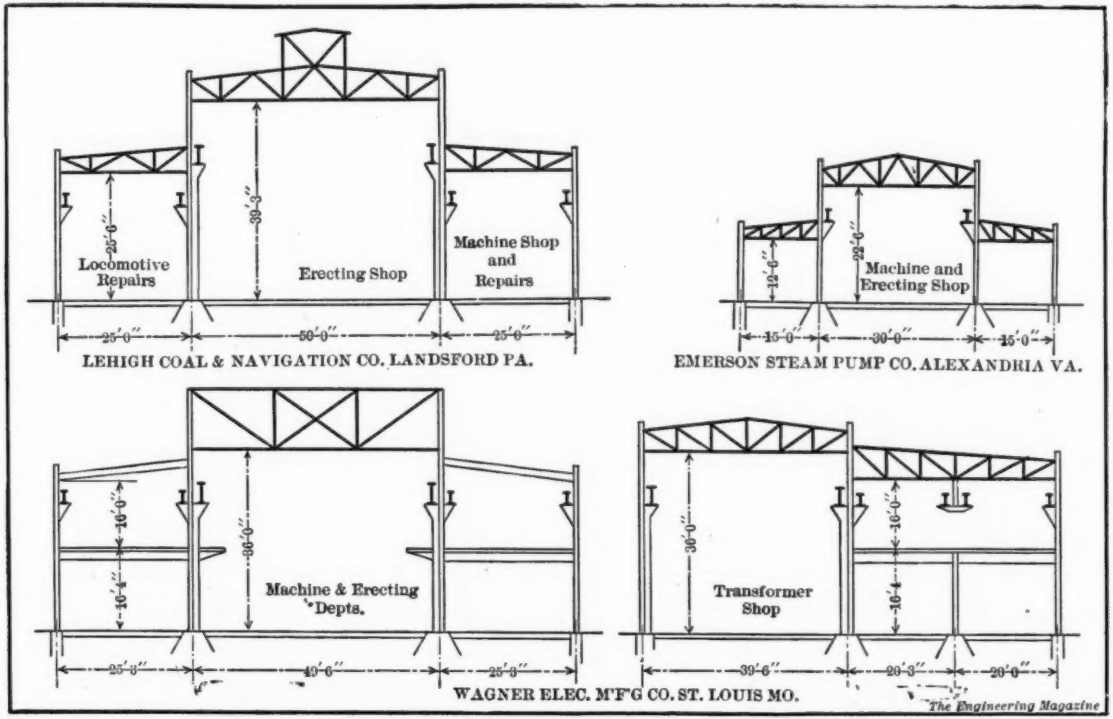
The buildings or sections of buildings required for repair or jobbing work differ widely in character, depending upon the characteristics of the work to be performed. However, their design is governed by broad conditions which affect principally overall dimensions in plan and elevation and also the floor loads. They have not the detailed peculiarities which are illustrated by the cross-sections of shops coming within the second group of our classification. The exception to this rule is presented by repair shops where definite requirements may be imposed by certain specific lines as previously referred to. As a rule, if the work that is to be handled is at all broad in its characteristics, there is required not only a section with considerable overhead room served by a traveling crane, but also an area with less overhead suitable for machine tools. Hence standard types of single or multiple-story buildings adapted to various classes of occupancy are not often adequate.

M (3) d—LABOR—Especially versatile in respective trades. Possibly not so capable at any one job as operators in shops of second class, but competent throughout a much wider range of performance.

The labor employed in repair or jobbing shops has the same broad characteristics as other factors that have been touched upon; namely, the various employees should be "all-around men" rather than specialists, and just as the all-around machine is not as efficient as the one designed for the performance of a specific job, so we cannot expect the versatile mechanic to attain as high an efficiency of performance as the specialist. The character of workmen required is a question that must be considered carefully by the engineer who is planning a new plant or extension, and also the status of the trades in question for the locality where the plant is to be built.

M (3) e—ADMINISTRATION—The system of management should be the one that will prove most effective under the circumstances that make it impossible to anticipate exact conditions from day to day. Each case must be worked out along special lines and often conditions are such as not to justify a highly perfected system.

The administration of all industrial plants should be based upon the same fundamental principles, irrespective of the nature of the work performed, but the details of the administrative system may differ materially for each of the three groups in our classification,



THE LEHIGH COAL & NAVIGATION SHOPS BELONG TO THE THIRD CLASS—REPAIR AND JOBBING WORK; THE OTHERS, TO THE SECOND CLASS, OF SPECIAL MACHINE SHOPS.

Note the dimensional difference between the Lehigh Coal & Navigation and the Emerson Steam Pump Shops. Note also division of areas for machine and transformer work and provision of galleries for the lighter operation in the Wagner shops.

and, in fact, must be varied for different plants coming within the same group.

The primary condition that must be dealt with in connection with a manufacturing plant is the one presented by an output made up of comparatively small articles turned out in large quantities and sold from stock; therefore, the work can be planned considerably in advance and with a very great degree of exactness. The repetitive nature of the work permits of the establishment of definite standards for the manufacture of the entire output, which standards when established are adhered to until the experimental departments have devised more efficient means.

Plants composing the second group possess the characteristics just referred to only in part. While all the output may be built in accordance with stock orders, the trade requirements are frequently such that it is not practicable to carry a very large number of duplicate units of the product. Standard methods of doing the work have to do more with the performance of detail operations than work upon the parts considered as a whole. The nature of the equipment employed must be such as to make it much more flexible, insofar as its uses are concerned, than is necessary in the manufacturing plant. Efficient performance requires, as a regular function of the administrative system, one or more specialists whose duties consist in the preparation of definite instructions covering the manner in which the various operations must be performed, taking into account the exact means that will be available.

The pronounced characteristics of the jobbing or repair shop are that it is practically impossible to plan the work as a whole for a considerable period in advance, nor is it possible to establish fixed methods of performing certain jobs of like character which may be received at odd intervals, as the necessity for completing such jobs in the least possible time may require somewhat different procedure in each case owing to the demands of other work that is being handled. Effective administration of shops comprising the group in question must necessarily be accomplished through a system permitting of very great flexibility, and there is required a degree of personal contact between the executive head and the shop superintendents that may not be desirable or practicable for plants in the first or second group. Each case must be worked out along special lines.

M (3) A, B, C, D, E—RÉSUMÉ.

It is obvious from the foregoing that plants for businesses or departments coming within this group can be laid out with the least precision, as compared with those composing the two groups

formerly considered. The equipment must be selected with a view to a wide range of performance rather than to the manufacture or building of a certain output. This wide range of usefulness, rather than the attainment of high economy of single operating, is usually the ruling factor. Occasionally the need of certain definite work requires the installation of special machines. The type of buildings must be based upon certain broad requirements, and to the extent that large and heavy work is handled they are special is character. Administration methods must be suited to comparatively uncertain conditions, and while in one sense such conditions call for the most highly perfected system, there may be incidental reasons which prohibit or do not justify their introduction. In any case the system must be one which operates from day to day.

While the foregoing discussion regarding repair and jobbing shop is too general in character to be of direct value to the engineer who is engaged upon the planning of a given shop, yet he will find that the solution is more readily attained if he himself and those with whom he is co-operating have a correct realization of the limits of the problem as compared with those presented when planning shops for work that belongs to the first two groups.

The shop of the Lehigh Coal & Navigation Company, illustrated on page 546, was designed primarily to handle repair and jobbing work. One of the side bays is provided with a drop pit and an overhead traveling crane that are used in connection with the repairing of standard-gauge locomotives. The other side bay is used in part for machine work and in part for the repair of narrow-gauge locomotives of the steam and electric types. The main bay of the shop is occupied by the large electrically driven machine tools and the department for the performance of miscellaneous repair work upon pumps, engines and general mine equipment. There is also a certain amount of new machinery built in this shop.

As previously stated, it is usually found that the requirements presented by a given metal-working buisness do not fall wholly within the clear confines of any one of the three divisions comprising the classification, although in almost every case there is a predominating tendency toward one of them. If this happens to be the first division, a definite and clear-cut solution should be expected; if the second division, the solution will not be as clearly defined and the selection of equipment, its arrangement, and that of the departments, will represent but a compromise of the to some extent conflicting requirements imposed by the diversified kinds of work; if the third division, the solution is usually but an approximation as it must be worked out from comparatively meagre data.

TIME KEEPING AND LABOUR DISTRIBUTION IN THE FOUNDRY.

By Victor R. Claydon.

III. KEEPING DOWN SHOP EXPENSES.

Mr. Claydon's articles are not addressed to the highly organized and amply officered foundry characteristic of a few of the latest and most advanced establishments, but to the modest plant which needs to study carefully the outlay of every dollar and the sufficiency of the returns secured. His argument is that the very practical, common-sense and simple records he advocates will much more than repay the small cost needed to put them into effect. His first article, in May, was on "Finding the Actual Value Received for Each Dollar Expended." The second took up "the Handling of Stores and Prevention of Waste." A concluding paper in August will show how all the information collected by his system may be brought together and made effective for economy.—THE EDITORS.

IN the two preceding articles that have appeared in this Magazine I have endeavored to point out the necessity of an employer's obtaining full value for his expenditure and at the same time knowing that he is doing so. We have also seen how imperative it is that the work performed by our employees should be correctly recorded and apportioned, and also that our materials should be under strict control and systematically handled. Even all this information, valuable as it undoubtedly is, will be of little service to us, unless full advantage is taken of proper means to remove the weak spots it will invariably show up. In short, it is not much use our finding out through these reports that our indirect labor is too high in the foundry, for a certain period, and then leaving the matter in the hope that it will right itself the following month. Points like this should be matters for serious consideration between the employer and the superintendent and foremen, and it is my purpose in this paper to deal with the various shop expenses and to endeavor to show that by a methodical way we can deal with these and obviate any undue expense in any or all of our shops.

First of all, then, it might be well for us to consider what a shop expense really is. In all works we are bound to have men who are neither directly nor indirectly connected with the manufacture of our staple products, yet at the same time their work is an essential factor, and consequently a burden on our whole output, usually apportioned as a percentage either on the direct labor or the good

castings made. For instance, it is necessary from time to time that repairs be made to our buildings or machinery; these are some of our shop expenses. For the purpose of illustration we may divide our shop expenses into two main heads, viz.: those which have to be apportioned on the tonnage and those which are percentaged on direct labor. For instance, flask renewals, cupola upkeep, moulding supplies, these are all tonnage charges, for the reason that the greater the output the larger the quantity of these materials used, and also the greater labor expenditure in consequence. On the other hand, maintenance of machinery, buildings, and tools, are governed by the amount of direct labor expended on our output, and obviously must be apportioned as a percentage of the direct labor on each class of good castings produced. There has been a great deal of argument as to why the whole of our burden should not be apportioned on the basis of tonnage, i. e., the net pounds of salable product. The reason I would assign for not doing so is that the items which go to make up our shop burdens are of two kinds. First, there are the items which necessarily increase with our output, such as those previously indicated, whilst in the second place there are those elements which do not seem to be in any way governed by the quantity of castings manufactured, for example, maintenance of buildings and such like charges, which would therefore be more correctly distributed by percentage of direct labor expended on our various classes of castings.

It will be seen at a glance that these indirect expenses will ordinarily amount to no small sum in a month; hence the necessity of some sort of system whereby they may be controlled. As I have previously stated, if these expenses are allowed to go on without question as to their necessity, then we at once allow for a very big leakage in our production costs.

In a previous article I hinted at the fact that our metal pattern department may become our graveyard, and as it is a very important factor in our costs I propose to show how and where the leakages may exist. In the first place, I think it will be conceded that almost all our employees in this shop will be day-work men, and one knows from experience that the best results are not readily obtained from day workers; hence it is essential that we have a good reliable foreman at the head of this department who will hustle and see that he gets the best out of the men under his control. Moreover, it will be easily seen that in a department such as this a good deal of our work, in fact the major portion, will be shop expenses, as all renewals

of patterns come under this heading, also metal flasks, etc.; and one knows from experience that the metal and tools used in connection with this work are no small item, to say nothing of the labor expended on them. Again, it often happens that the foundry has to call upon the machine shop to do repair work for it; and if track is not kept of the time spent by the men executing this work, the machine shop would have to stand the expense, which on the face of it is wrong. To offset such chances of error as this, and better still to give us a line on the numerous repairs that are going on in each department, we must in the first place classify our principal shop expenses, and this may be done in the following way:—

1.	Wages and Materials for Cupola (including Repairs)	Tonnage Charges.
2.	" " " " Moulding Supplies.....	
3.	" " " " Renewals of Flasks.....	
4.	" " " " Maintenance of Machinery and Tools.....	Direct Labor Charges.
5.	" " " " Maintenance of Buildings.	
6.	" " " " General Shop Expense...	

All of these, with the exception possibly of No. 6, are self-explanatory. With regard to No. 6, one might say that the purpose of this charge is to cover such incidental charges as cannot be put to any of those before mentioned. For example, a man whose duty it was to sweep up the shop would be charged to this expense, as also would brooms, waste, etc. In the event, then, of the foreman of the foundry requiring a repair to a moulding machine, it would be necessary for him to issue an order on the foreman of the machine shop to execute the same; further than this, in order that the work may be kept track of in the departments through which it is expedient for it to pass, copies of this order should be sent to the respective foremen, viz., foundry, cleaning shop, machine shop, and the timekeeper should also receive a copy. A form like that suggested on the opposite page might conveniently be used.

The back of this form should be divided into two parts, and the divisions headed "Labor" and "Material" respectively. As soon as the work called for in the order has been completed by the foundry, the foreman of the foundry should turn his copy of the order to the timekeeper, together with a report (written on the back) as to all labor and material expended by his department on this expense; the same process being gone through by the foreman of every shop through which this work passes. As soon as the timekeeper has re-

ceived all these orders, as completed by the shops, he will make up the total cost of the work, and file the order; or place the final cost before the superintendent for his perusal. The advantages accruing from an order system like this are numerous. One can readily understand how useful such information as this will be to the superintendent, as he can detect any undue expenditure on the part of any or all of the shops and prevent repetition. This is the only way in which to minimise our shop-expense charges.

SHOP EXPENSE ORDER.

DATE ISSUED, *26/11/09.* To Foreman of *Foundry.* NUMBER *381.*

Pease have made for the Machine Shop
Casting to sample, charging all labor
and material to undernoted charge.

Copies Sent To:—*Timekeeper, Foundry, Cleaning Shop, Machine Shop.*

Classification No. *37/17.*

Signed, *H. W. Jones,* Foreman of *Machine Shop.*

Approved, *J. G. Webster,* Superintendent.

Cost of Labor $..... Cost of Materials $..... Total Cost $.....

FACE OF FORM FOR ORDERING REPAIRS.

It may be argued, however, that it is not necessary for a foreman to get an order signed by his superintendent for every little thing he requires to be done in or by another shop. This question must be determined to some extent by the conditions prevailing in the works, but I would suggest that for shop-expense orders for minor amounts, say under $10, the signature of the foreman should be a sufficient warranty for the carrying out of the orders, but for items which are likely to cost a much larger sum these orders should be considered duly authorized only when the signature of the superintendent is appended thereto. For instance, supposing the foreman of the foundry reports that he requires repairs to a machine which in his opinion will cost about $150 to put right. It might of course be proper for him to go ahead with the work, but in the first place it should be necessary for him to call the attention of the superintendent to the repairs which he considers necessary, and if everything is O. K., the superintendent will not hesitate to append his signature to the order. On the other hand, however, it might be found that it would be far more practical to get a new machine altogether, or to do the repairs in some different way from that originally outlined by the foundry foreman. I would

like to lay particular stress upon the necessity of frequent consultation between the foreman and superintendent, especially in connection with matters of shop expense, as it is here in many cases that we find the causes for our high burdens. By using such means as these a superintendent is enabled to keep a much closer tab on all that is going on in the different shops; and in a large plant countless repairs and replacements are necessary, and I should imagine that unless some similar system to the one here outlined is in force, it would be almost impossible to look after the hundred and one jobs that crop up every day. It may also be noted that on the shop-expense order form, each foreman or his clerk has to enter up the men's time and the materials used on each of these jobs, so that when the work is completed, the management knows at once just how the expenses are running; but more than that, they know which shop is costing the most in proportion for upkeep and can at once lay their hands on any leakage that may exist.

In looking over an article on cost accounting that appeared in the *Iron Age* some time back, I was very much struck with the opinion of the writer who said that too much "paper work" was as bad as none at all, as where so much detail is gone into the management has to keep an excessive number of clerks in order to get out the details required by them. This is unquestionably true, and one must guard against such a condition of affairs. The simpler the cost system the better, so long as it gives the superintendent and management the pertinent facts, upon which so much depends. My idea in these papers has been to avoid as far as possible an overburdening amount of paper work, but yet at the same time to retain all the valuable information.

In connection with the issuing of shop-expense orders, it is always expedient that the form used should be as explicit as possible, otherwise a good deal of time is wasted in making explanations, or making quite clear to the different foremen what is actually required. In order to prevent this a few rules might be drawn up relative to these, and a copy given to every one having anything to do with shop expenses. I would therefore suggest the following as being practical, and worthy of consideration:—

1.—When it is necessary for one shop to make requisition on another for any work whatsoever, it is requested that the foreman state explicitly on the shop-expense order what is required.

2.—He should also give enough information so that the timekeeper and cost clerks looking after the work can correctly distribute the several expenses.

3.—For orders where the cost is not likely to exceed the sum of ten dollars, the foreman of the shop upon which the order is drawn should honor same if signed by the foreman of the shop issuing it. In the event of an expense costing more than this sum it is essential that the order be countersigned by the superintendent.

4.—Any order issued for repairs to machinery should specify the number of the machine on which such repairs are to be made.

Other rules may of course be added at the discretion of the parties handling these orders, but in the majority of plants I venture to think these will be sufficient.

It must be borne in mind, however, that it is imperative these rules be faithfully carried out, and that obedience be insisted upon, or else we shall soon find out that the information we are getting is not of much value.

Here, then, we have a very simple method of dealing with the various expenses that are bound to occur in our works, and I believe that if the orders are carried out on the lines suggested in this paper we shall be able without much effort on our part to detect the causes of high burdens in the shops, and to reduce them accordingly. As before stated (and I think it worthy of repetition) strict adherence to the rules laid down is essential, and must be enforced at any cost.

There is no excess of paper work in this order system, as the requisite number of copies of each order can be made at one writing on the typewriter, and distributed to the various shops by the timekeeper.

In conclusion I would urge the necessity of co-operation on all sides, as it is only by unity of purpose that the desired ends can be reached.

In the concluding article of this series it will be my endeavour to bring together all the information necessary for compiling our final cost reports, and to show how the information so collected may be put to the best use.

THE REVIVAL OF THE RECIPROCATING ENGINE.

By R. J. S. Pigott.

I. COMPARISON OF THE ENGINE AND TURBINE THERMAL CHARACTERISTICS.

Mr. Pigott's theme is the very high economy in the production of power secured by the large piston engine combined with the low-pressure turbine. His article in this issue deals with thermal considerations and problems of design in getting up a good combination unit. A second paper, in August, will discuss practical applications, either to new installations or revision of old reciprocating-engine plants by the addition of low-pressure turbines.—THE EDITORS.

SINCE the development of the low-pressure turbine in Europe, and its recent advent in large units in America, the builders and owners of reciprocating engines are taking fresh interest in the possibilities of economical power production by piston machines. The low-pressure turbine, until recently, has been used chiefly in connection with a regenerator, to render a comparatively uniform and economical power supply from the irregular exhaust of one or several uneconomical engines operated intermittently. It is now applied directly to a single engine operating continuously, and without a regenerator, to carry expansion of the steam to a point far beyond the economical reach of the reciprocating machine. This combination has such marked advantages in economy over both reciprocating engine and high-pressure turbine, that it becomes a formidable rival to the two simple types in many fields.

The theoretical considerations which make these advantages possible are quite simple. Assuming a given initial condition of steam, p_1v_1, the work per unit weight obtainable by expansion, if there are no losses by friction, leakage, radiation or conduction, is shown by the area A B C D, Fig. 1, represented by the familiar $\int vdp$ where $pv^{1.126} = c$ is approximately true for adiabatic expansion. This area could be realized only in an engine with no clearance, instantaneous valve opening and closure, no leakage, non-conducting cylinder walls, and unlimited port area; or in a turbine with no nozzle and wheel friction, non-conducting shell, no exit velocity from the wheels, and no internal steam friction. These conditions are, of course, never realized. But the nature of the losses in the two machines is entirely different, and changes enormously with the pressure range; this is where the combination engine-turbine unit gets its chief advantage.

Generally the most important loss of the reciprocating engine is condensation, caused by conductivity, heat capacity of the cylinder walls, and bad drainage of the cylinder. Few realize the enormous influence of a small amount of water in the cylinder upon the heat transfer and state of the steam contained therein. Initial condensation forms the greater part of the total condensation. At the time of admission the cylinder walls and all other metal bounding the clearance space are all at a temperature somewhere between the average temperature and the lowest temperature of the engine cycle, and are comparatively cool. The compression of a small amount of steam in the clearance space does not serve to increase their temperature very materially; consequently the incoming steam is chilled by the cool surfaces and throws down some water. This condensation is rapidly increased, not only by the additional cool surface exposed as the piston moves away, but by the deposit of the condensed water film on the surfaces, which enormously decreases the resistance to heat transmission, and so assists the increase of moisture. This action probably continue until the rising cylinder-wall temperature equals that of the steam. Then the action reverses and the hot metal gives up most of the heat absorbed to the water film, some of which is then re-evaporated. We can safely say "most of the heat" because in a modern engine, with good lagging, the actual radiation and conduction to the surrounding air need be very little—not more than 2 per cent. Consequently 98 per cent is returning to the steam during the remainder of the expansion stroke and the exhaust stroke when the steam temperature is lower than the cylinder temperature. The heat transferred during exhaust is useless to do work in the cylinder and only goes to increase the intrinsic energy of the exhaust steam, so that not as much energy has been given up by the steam as if no condensation took place. This is all right in the case of a high-pressure cylinder where the exhaust steam is to be re-used in a second cylinder; but in the case of the last cylinder, the extra heat returned to the steam goes to the condenser and is lost.

The actual temperature range in the cylinder walls is much smaller than is ordinarily supposed. At a depth of .01 inch below the surface it is about 1/10 or 1/11 the steam-temperature range, and at the surface, not much greater than 1/7 to 1/9; so that the loss from condensation in well lagged cylinders is generally much less than is ordinarily believed. The popular idea is that condensation losses are chiefly due to radiation and conduction, but they are really due to the alteration of the heat contents of the steam at different periods of the stroke by the presence of a small quantity of moisture, so that

the steam leaves the cylinder dryer than if a true adiabatic expansion had taken place. This implies that less heat has been withdrawn from the steam and consequently less work has been done per pound. In addition to these, the jet action of the steam etering the cylinder may become considerable and the work of projecting the mass of steam at fairly high velocity and reduced pressure with imperfect compression, produces moisture; the kinetic energy generated is used up on the cylinder walls as heat of impact. While little or no attention has been paid to this point, it may be that, insignificant as this thermo-dynamic action seems, it is just enough to start much more serious condensation action.

The item of leakage is nearly as important as condensation, and in many cases without doubt, is actually greater. For, although most designers think that their own pet packing design is a puzzler for the steam, the actual commercial products have a suspiciously similar look—all have one or two comparatively narrow sliding surfaces, which are supposed to be in close contact—so they may be when new—and cold! But the amount of water and steam that can leak by a capillary opening, such as obtains with pistons and all forms of sliding or rotating valve, is incredibly large—out of all proportion to the amount leaked when the orifices are measurably large.

Indeed, one of the chief reasons why no generally applicable formulæ for missing water have been offered, is the uncertainty of this leakage factor. No one can predict by formulæ just what the leakage may be past piston and valves. The remaining departures of the actual engine from the ideal are due to purely mechanical limitations; clearance, rounding of corners of diagram, non-completion of expansion, and in compound and triple-expansion engines, pressure drop at release in high-pressure or intermediate cylinders.

The absolute amount of all these losses is usually approximated by formulæ involving constants which are determined by actual tests upon any engine under consideration, or if these are not available, by tests from similar types of engine.

Initial condensation will be proportional to: (a) temperature range; (b) surface exposed; (c) time of exposure; consequently initial condensation will vary in some function of ratio of expansion, cylinder diameter and speed. Ratio of expansion, r, is defined as total volume divided by cut-off volume. Condensation by expansion will also be proportional to r. Leakage past valves and piston will increase with pressure range and consequently with heat interchange, and therefore condensation and re-evaporation will be less as period is reduced or speed increased. The other mechanical losses are ques-

tions of design and are practically the same in all well-designed engines.

From the above, we should expect the missing water to vary according to some function $f(r, d, p_i, n) = y$

where r = ratio of expansion
d = cylinder diameter.
n = number of revolutions
p_i = initial pressure

Various formulæ have been used:

$$y = c\,\frac{1+r}{d\sqrt{n}}, \qquad y = \frac{c^{1}(1+r)}{d\sqrt{np_i}}, \qquad \text{—Perry.}$$

$$y = \frac{c^{11}\log r}{d\sqrt{n}} \qquad \text{—Cotterill.}$$

$$y = \frac{c^{111}\sqrt{r}}{d\sqrt{n}} \qquad \text{—Thurston.}$$

$$y = r\left\{\frac{a}{np_i} + \frac{b}{d\sqrt{n}}\right. \qquad \text{a \& b are constants.} \quad \text{—Callendar \& Nicholson.}$$

The interpretation of all the above formulae is: missing water is less as cut-off is longer; is less as the engine is larger; is less as the speed is greater; and in a small degree is less as the initial pressure is greater. The variation of form shows how uncertain the whole matter is. But we should expect that a non-condensing engine would come nearer to the ideal than a condensing engine, since ratio of expansion is the most important factor. This is borne out by fact; take the engines at 59th Street, before and after installing the low-pressure turbines. Pressure, speed, and dimensions are the same; consequently missing water becomes a function of r only; running condensing with r approximately 20 or 22 at nominal load, the efficiency referred to the Rankine steam cycle never rose above 60 per cent; whereas when operating non-condensing, r approximately 8 or 10, efficiency nearly reached 80 per cent. In fine, the reciprocating engine is a much better machine for transforming heat to work above atmospheric pressure than below, although the actual water rate, when running non-condensing, is much higher, because the ideal cyclic efficiency is less. This applies both to simple and compound engines, if the initial pressure is over 125 pounds. As an example, the 59th

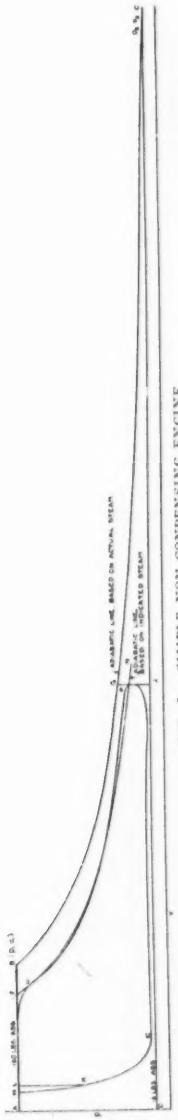
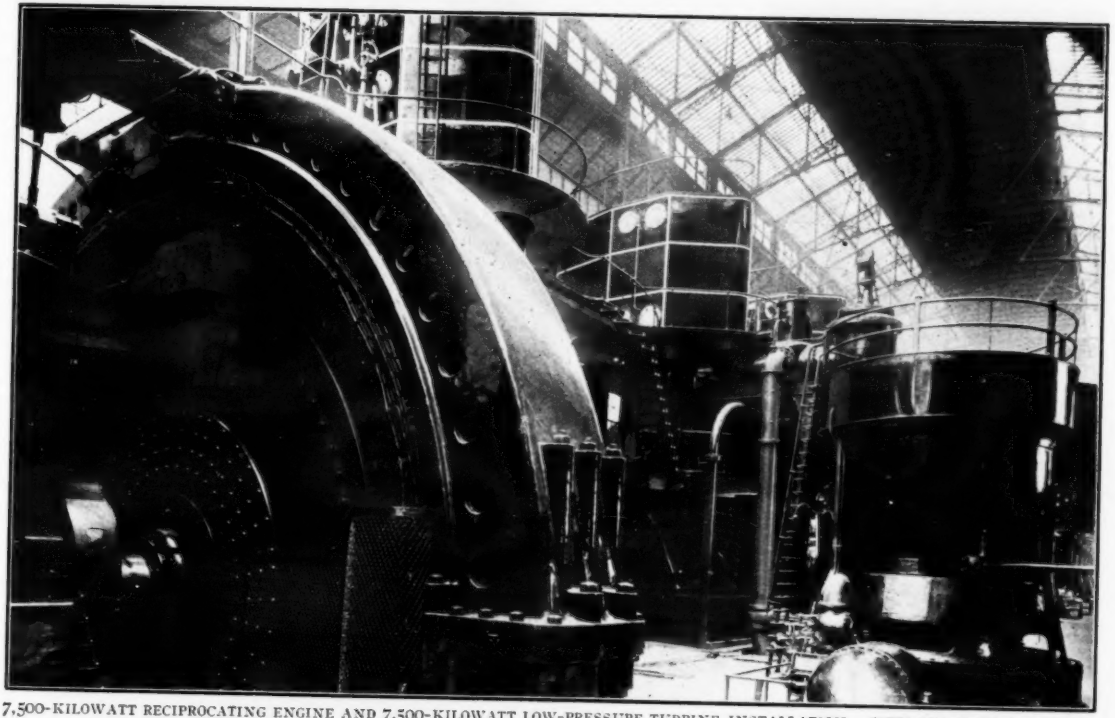


FIG. 1. SIMPLE NON-CONDENSING ENGINE.

Street engines running condensing, gave a kilowatt hour on 17.1 pounds dry steam at 4,600-kilowatts load, when the ideal engine would have given a kilowatt hour on 9.1 pounds, which gives 59 per cent efficiency referred to the ideal; the thermal efficiency of the ideal engine for these conditions is 28 per cent, giving a thermal efficiency for the actual engine of 16.7 per cent. Running non-condensing, exhaust going to the low-pressure turbine, the engine gave a kilowatt hour on 24.6 pounds dry steam, the ideal engine using 19.3 pounds, or 78.5 per cent efficiency for the engine; the ideal thermal efficiency is in this case 17.6 per cent, giving 13.8 per cent thermal efficiency for the actual engine. These are all over-all efficiencies, and include the generator losses—the generator efficiency alone being from 97.5 per cent to 98 per cent. The triple-expansion engine does not enter into the field to any great extent, as there are practically no examples, except marine engines, to which a low-pressure turbine might reasonably be applied.

The losses in a simple engine can be easily understood from Figure 1, where A, B, C, D, is the work area by a true adiabatic expansion from dry steam at p, v, and is the card upon which the Rankine ideal cycle is based. A, F, shows the reduced volume due to initial condensation, the expansion line from o to p following no simple law exactly, although it follows approximately some such law as $pv^{1.106} = c$ or sometimes $pv = c$, this last being frequently miscalled the "theoretical" expansion line.

G, C, J is the loss due to incomplete expansion. The area K, L, M, is part of the loss due to incomplete compression in the clearance space, the remainder of the loss being in the departure of E, K, M from an adiabatic compression. The actual steam per stroke is represented by the difference A, B and A, M.



7,500-KILOWATT RECIPROCATING ENGINE AND 7,500-KILOWATT LOW-PRESSURE TURBINE INSTALLATION. 59TH STREET PLANT OF THE INTERBOROUGH RAPID TRANSIT COMPANY.
Allis-Chalmers Engines. Curtis Steam Turbine.

Figure 2 shows the same characteristic losses for the compound engine, but the amounts are reduced, since for the same ratio of expansion, the temperature ranges are halved, clearance reduced, and an opportunity given to drain away some of the injurious moisture. But on the other hand, while missing water is thus much reduced, valve losses, as evidenced by rounding of the card, are increased, and an additional radiation surface in the shape of a receiver is introduced, also a slight additional loss from the usual drop from high-pressure release to receiver pressure. There is, however, a very substantial gain, in spite of these losses, in favor of the compound.

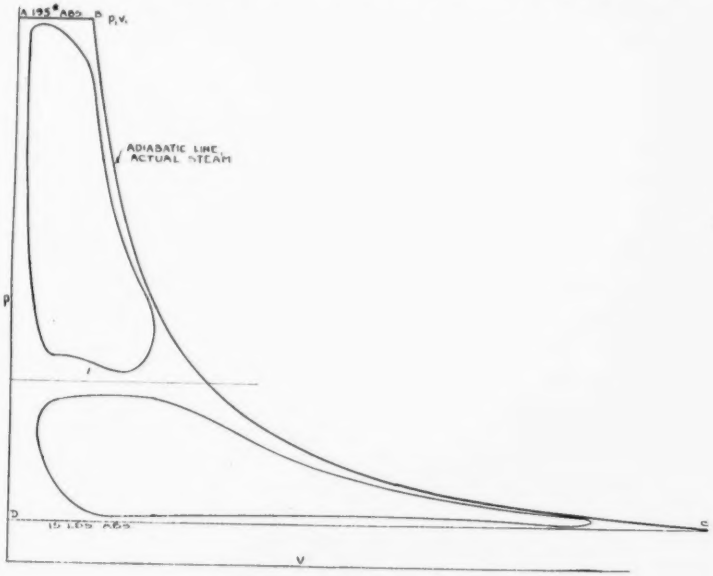


FIG. 2. COMPOUND ENGINE, NON-CONDENSING.

In the turbine, the principal losses are: internal nozzle friction, skin friction, wheel friction, exit velocity, and in the case of reaction machines of the Parsons type, leakage around blade ends. Radiation from the turbine to the surrounding air is almost immeasureable, as the surface presented to the air is very much smaller, compared to the power, than in the case of the engine. It is easier to insulate the turbine thoroughly, not only because of the simplicity of the lagging and the absence of externally moving hot parts, but because of the absence of large bodies of metal (such as the guides, piston rod, valve bonets and gear in the engine), leading from the steam chambers to

unlagged cool parts. In the steam engine the guides, rod, and valve fittings probably account for more dissipation of heat than the whole radiating surface of the cylinder.

The internal nozzle friction is due to variations of steam flow from the conditions for which the nozzles or wheels were designed, setting up eddies in the steam which use up a portion of the kinetic energy in useless, cross-currents, whose energy in turn is returned to the steam as friction heat. The blanketing of the steam by the sensibly thick blade edges and the windage of the wheels, have this same effect. That is, all eddy currents and friction go back into the steam as internal energy. The result is that the steam exhausted from one wheel to the next and finally to the condenser or atmosphere, is always much dryer and much higher in internal energy than if the expansion were adiabatic; consequently less work has been done.

The friction of steam, whether internal or skin effect, is much greater at high than at low pressure, on account of the much higher density and viscosity, so that a high-pressure stage is much less efficient as an energy transformer than a low-pressure stage. The efficiency as a transformer of a high-pressure nozzle and wheel usually amounts to about 62 per cent; that of a low-pressure nozzle and wheel about 71 or 72 per cent. In the case of the impulse type, the expansion nozzle is stationary, and the wheel merely a reversing guide; in the reaction type, the wheel and stationary blades all partake of both functions, but the losses are much the same in both cases. The increased efficiency of the nozzles and wheels becomes more and more pronounced as the pressure drops, so that the last vacuum stages probably have an efficiency of over 80 per cent. This is one of the reasons for the enormous gains in economy of the turbine with increased vacuum. Consequently the turbine is inherently a better machine for low-pressure work than for high.

The diagram Figure 3 will perhaps show a little more clearly the condition obtaining in the turbine. The work done by a true adiabatic expansion following a law $pv^{1.126} = c$ approximately from p_1v_1 to p_2v_2' is $\int_{v_1}^{v_2'} vdp$, area A, B, C, D, and can be directly represented by $\lambda_1 - \lambda_2'$, where λ is the total internal heat in any state. What actually occurs is shown by A, B, E, D, expansion following a law $pv^{\nu} = c$ and terminating in a different volume, v_2 and a higher heat contents, λ_2. The work done is still represented by $\lambda_1 - \lambda_2$ but not by $\int_{v_1}^{v_2} vdp$. The loss of effectiveness is represented by the difference of heat contents, $\lambda_2 - \lambda_2'$.

The application of superheat to both turbines and engines effects an improvement in economy. The improvement in the steam engine

is chiefly due to the elimination of most of the missing water, by providing enough superheat to counterbalance the chilling effect of the cool cylinder, without producing moisture. We should, therefore, expect a very large improvement with small superheat, say up to 75 degrees F. at the throttle, and very little additional improvement with higher superheats, as there is nothing to be gained by sending superheated steam to the condenser.

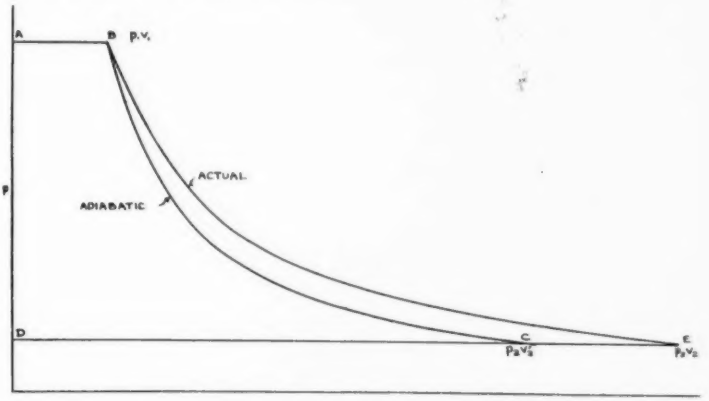
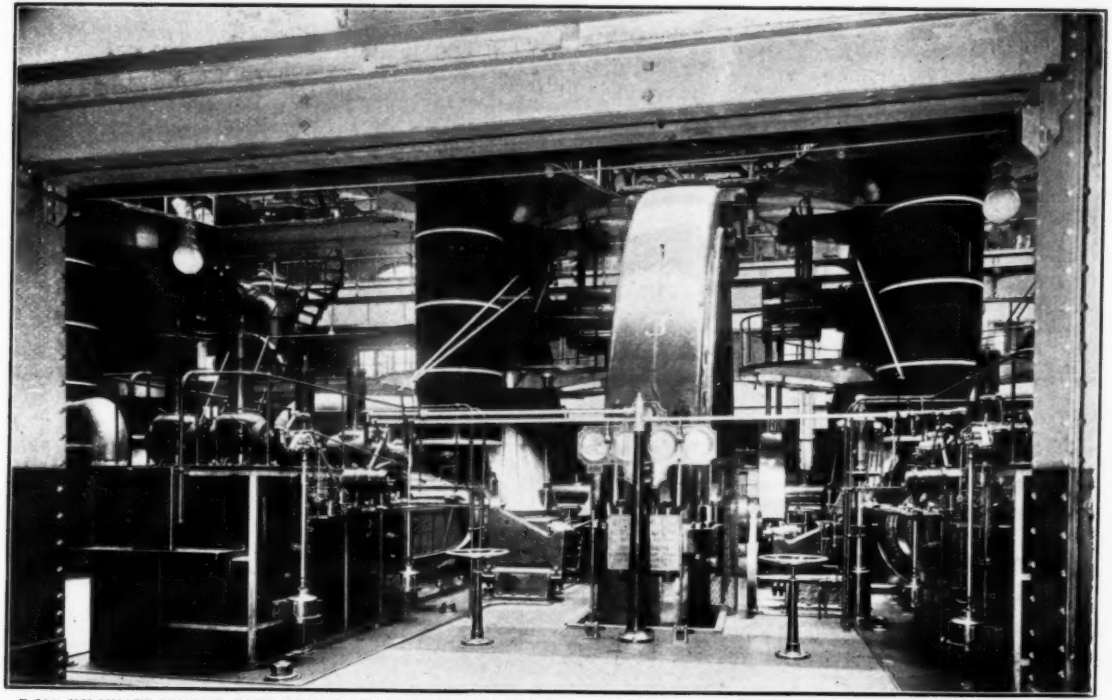


FIG. 3. TURBINE.

In the case of the turbine, the superheat effects its saving by cutting down the friction losses, so that the expansion is more nearly adiabatic. The viscosity and specific density of superheated steam are considerably less than those of saturated steam for the same pressures, and the elimination of moisture in the expansion reduces the friction enormously. We should expect very little additional saving when superheating beyond the point of saturation at exhaust; this is actually the case, the same as with the engine.

But these improvements in economy do not materially affect the basic fact that the engine is more efficient at high pressure, and the turbine at low pressure. The natural conclusion is that a combination unit giving each its most efficient place on the pressure scale, would prove more efficient than either alone. For, if the engine efficiency is 82 per cent non-condensing, and the turbine efficiency on dry steam is 70 per cent, running from atmospheric pressure to vacuum, a combination unit could be expected to reach an efficiency of about 74 per cent with properly divided load. This figure has already been realized. Figure 4 will serve to show the general character of the saving.



7,500-KILOWATT ENGINE, 59TH STREET POWER HOUSE OF THE INTERBOROUGH RAPID TRANSIT COMPANY, SHOWING VALVE GEAR. The modern high-pressure turbine under the same conditions is 13 per cent. more efficient. The low-pressure turbine combination is 25 per cent. more efficient. Allis-Chalmers engines; Westinghouse generator.

There are a number of very valuable advantages, which are incidental to the question of economy of steam. The principal advantage is the increase of power, which can be obtained in any overloaded engine plant, without appreciable increase in steam. There are many manufacturing plants of 500 to 2,000 horse power, whose owners are at their wits' ends to provide power enough, economically, without a very heavy outlay of money. In many cases where the factory has outgrown the plant, and where space and building room are available, the low-pressure turbine offers a splendid solution. Its small size will usually allow of its introduction without alterations to the building, or foundations already installed. If the engine steam piping is reasonably well designed, it will suffer no changes

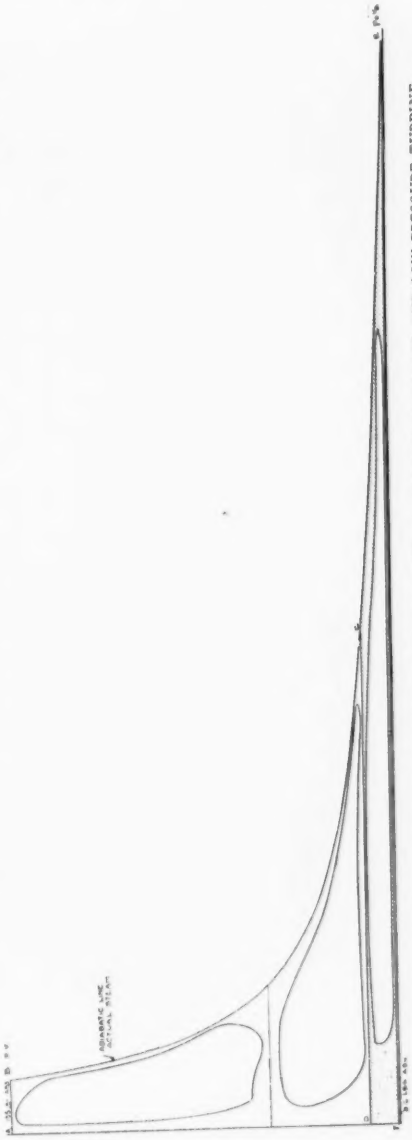
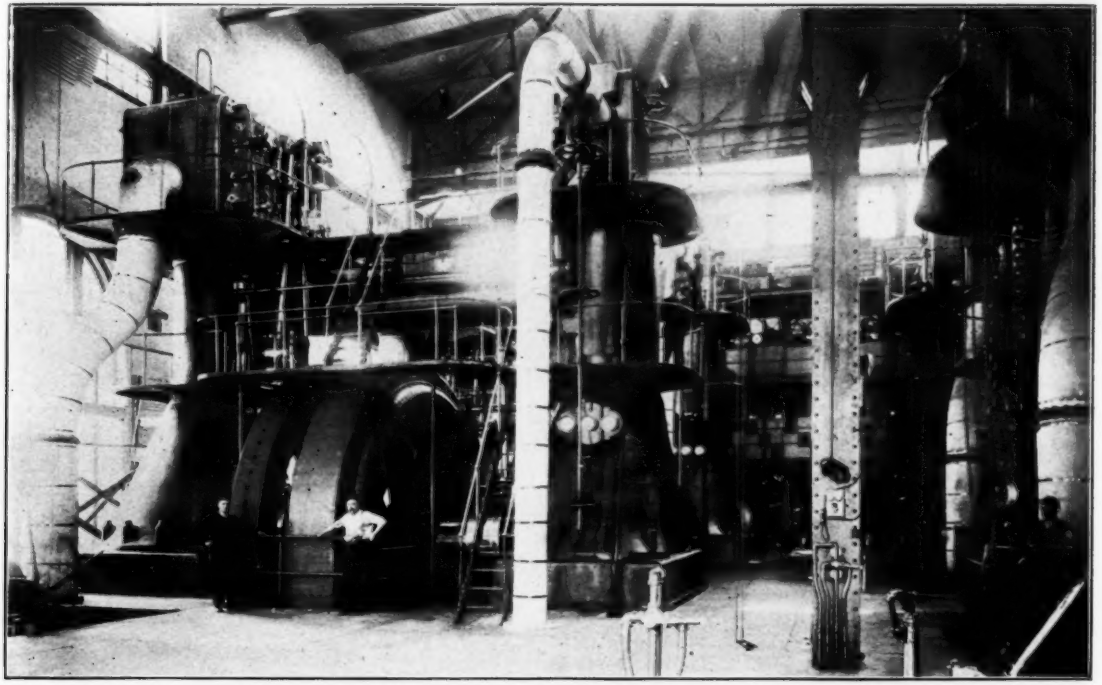
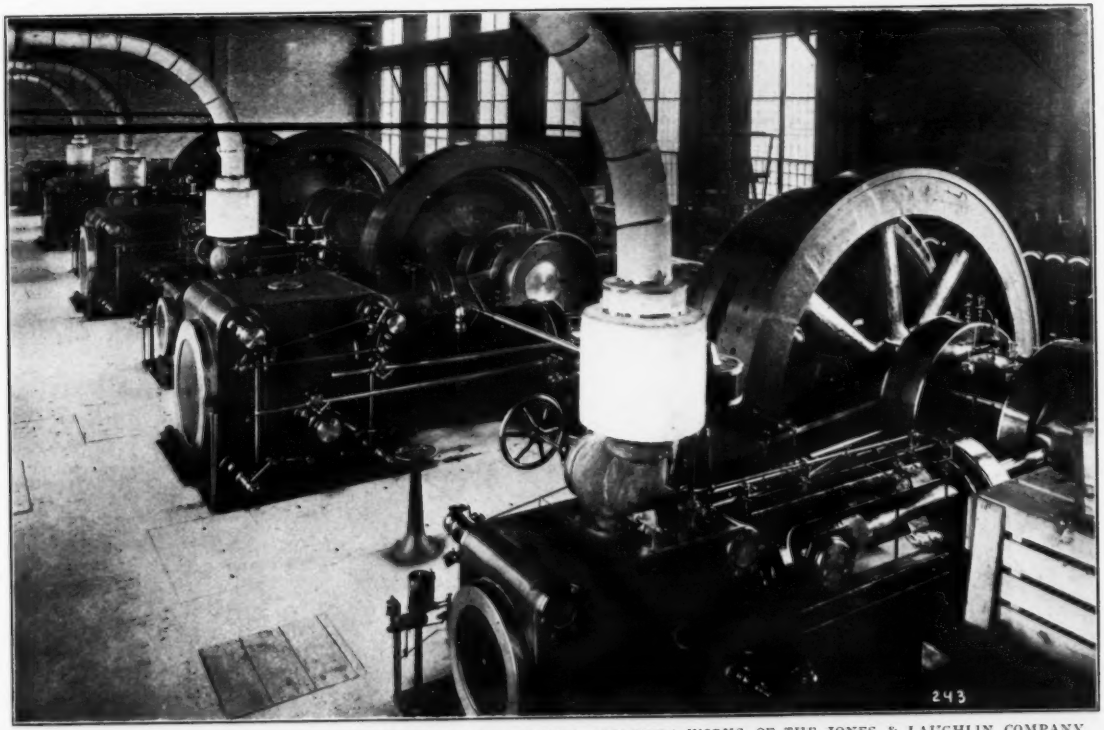


FIG. 4. COMPARISON OF A TRIPLE-EXPANSION ENGINE WITH A COMPOUND ENGINE AND LOW-PRESSURE TURBINE.
A B E F is the total available; D C E F, shaded portion, shows additional work from low-pressure turbine as against third cylinder.



TWO OF FIVE 2,400 HORSE POWER VERTICAL CROSS-COMPOUND CORLISS ENGINES, COAL STREET STATION OF THE PUBLIC SERVICE CORPORATION, NEWARK, N. J.

Wisconsin Engine Co. An installation of low-pressure turbines in this station is under contemplation.



FOUR 2,000 HORSE-POWER HORIZONTAL CROSS-COMPOUND ENGINES, ALIQUIPPA WORKS OF THE JONES & LAUGHLIN COMPANY. 28 and 56 by 48 in. At present working on saturated steam at 135 pounds. The Wisconsin Engine Co.

whatever. The auxiliaries, although larger, with the latest designs, take so little extra space that, in practically every case, they can be substituted for the original auxiliaries without further change. The addition of the low-pressure unit usually does not mean any addition to the engine-room force, as the turbine itself requires no attention that could not be given by an oiler already taking care of the engine, while the auxiliaries require only the same care as for the engine installation alone.

In may cases, where the load factor is high, the initial installation of the combined unit may prove advisable, since economy of operation then becomes of prime importance. In cases where the load factor is small, the high first cost of a combined unit militates against its adoption. It is in the case of the old plant which is overtaxed that the turbine has its strongest field.

In the next article the calculation of a typical case or two will be taken up.

THE COST OF LIVING: HAS IT RISEN, AND WHY?

By Alex. Del Mar.

Mr. Del Mar was formerly Director of the U. S. Bureau of Statistics. He is a recognized authority on the use of the precious metals as money and on other phenomena of finance.—THE EDITORS.

ABLE speeches have been delivered in Congress and able articles have appeared in leading newspapers concerning the recent rise in the cost of living in the United States; yet none of them appears to have determined the fact definitely, or to have adopted a method which, when the fact was determined, was capable of disclosing its underlying causes.

What is meant by the cost of living in the United States is not merely the wholesale unit prices of the ninety-six commodities embraced in Bradstreet's very excellent and reliable American Price Tables, or the wholesale quantitative prices of a similar list of commodities in Saurbeck's British Tables; but the actual cost of rent, services, commodities and miscellanies to the average American citizen. To add the cost of a pound of butter at 30 cents to that of a pound of flour at 3 cents, and compute the cost of bread-and-butter at 16½ cents per pound, would be no more erroneous than the method employed in some of the otherwise very admirable articles which have been published on this subject; while as to rent, which is the heaviest article of expenditure to the average citizen, it is not so much as mentioned in any of them. Neither is coal mentioned. A "ton" of this fuel used to weigh 2,240 pounds and cost about $5 or $5.50; that is to say, the consumer used to get something like 4 pounds for a cent. The poor man's "ton" now does not commonly weigh over 1,500 pounds and costs $6; he gets but 2½ pounds for a cent. As the usual consumption of the average Northern household varies from 10 to 30 tons a year, this item forms no inconsiderable element in the cost of living. It is far more important than the majority of the commodities usually included in the quoted price tables.

Servants' wages and the cost of their maintenance; the daily expense of transportation (car-fares, commutation-tickets, expressage, etc.), the cost of the business-man's or working-man's lunch, the fees which he is obliged to pay to physicians, dentists and other professional men, and those smaller, but in the aggregate, commonly more

important expenses which include the barber, the porter, the waiter, etc., all these are left out of view in these discussions. Yet they have to be met, and therefore have something to do with the cost of living.

We next turn to clothing, hats, shoes, gloves and underwear. None of these articles appear in Bradstreet's or Saurbeck's tables, yet they form a very considerable item of expense to the average citizen and especially to the American, because for reasons connected with our fiscal system the most important of these articles have come to be made of such flimsy materials that they scarcely outlast a single season; whereas in other countries a good suit of clothes lasts for years without appreciable deterioration. Similar considerations affect the expense for furniture, carpets, hangings, and indeed almost every article of household use. In other countries they have to be made to last; in the United States they are made to sell. Second-hand foreign furniture commands with us a higher price than new domestic furniture of the same styles and (apparently) the same materials. The flimsiness of American furniture, carpets, and other household goods causes them to wear away after very brief use, so that their renewal becomes a far more important item in the cost of living than it is in other countries; yet these articles nowhere appear in the tables of prices which have been published concerning the cost of living. It is true that furniture would be a difficult commodity to describe, classify and quote; but such is not the case with carpets, rugs, oilcloths, hangings, blankets, bedding, etc., all of which are classifiable and amenable to definite quotation.

Defective Methods.

The result of employing defective methods is that in some of the researches which have been made, no definite conclusion has been reached; while in others the conclusion has been erroneous, it having actually been shown by at least one writer that the cost of living has not risen, whereas universal experience and more rigid research combine to attest that it has risen, and risen very materially.

Fortunately for the determination of the matter we possess criteria that will not be questioned. These are the carefully compiled and officially promulgated data prepared by the Bureaus of Statistics and Labor in the Department of Commerce, from which the following Tables are quoted. For purposes of comparison we begin with the wholesale prices.

Wholesale Prices—All Articles

"The average wholesale prices of 258 staple commodities during the ten years," 1890-1899 being reduced to 100, the relative prices of the same articles in each year separately, commencing with 1897 were

as follows: 89.7; 93.4; 101.7; 110.5; 108.5; 112.9; 113.6; 113.0; 115.9; 122.5; 129.5; 122.8; 126.5. So that if to purchase these commodities during the last decade would have cost $100, in 1900 they would have cost $110.50 and in 1909 $126.5; showing a rise since 1897 of 41 per cent.

Wholesale Prices—Food Only.

Included in the 258 staples above quoted are 57 of "Food, etc.," and these being based at 100 during the decade 1890-1899, they exhibited the following relative prices in each year separately, beginning with 1897: 87.7; 94.4; 98.3; 104.2; 105.9; 111.3; 107.1; 107.2; 108.7; 112.6; 117.8; 120.6; 124.7. This table shows that the advance in the wholesale prices of food, etc., has kept almost equal pace with the advance in wholesale commodities generally. We now turn to retail prices.

Food—Retail Prices.

The following table shows the relative quantitative prices in each year since 1897 of 30 selected articles of food, the relation being based on 100 for the average quantitative prices during the decade 1890-9:

Year.	Simple prices.	Quantitative prices.
1897	96.3	96.3
1898	98.5	98.7
1899	99.6	99.5
1900	101.5	101.1
1901	105.5	105.2
1902	110.9	110.9
1903	110.9	110.3
1904	111.6	111.7
1905	112.5	112.4
1906	116.2	115.7
1907	120.7	120.6
1908	125.0	124.8
1909	129.1	130.4

The computations for the last two years are unofficial.

The articles included in the above table are dried apples, dried beans, roast beef, beefsteak, salt beef, wheat bread, butter, cheese, chickens, coffee, corn meal, eggs, fresh fish, salt fish, flour, lard, milk, molasses, pork, salt bacon, salt pork, potatoes, prunes, rice, sugar, tea, veal, and vinegar. The quantitative price is computed by giving to the relative price of each article its proper weight, as determined by the average consumption in 2,567 families of workingmen. It will be observed that in the case of food, there is very little difference between the simple and quantitative prices; but this is not the case with other commodities.

Food—Retail Prices of Principal Articles.

If we select from the 30 articles of food the 6 most important ones, their relative retail prices would run as follows:

Year.	Beef, steaks.	Wheat flour.	Butter	Pork fresh.	Potatoes Irish.	Eggs.
1890-9	100	100	100	100	100	100
1897	100.2	104.3	93.1	97.6	93.0	91.4
1898	102.0	107.4	95.1	98.6	105.4	96.2
1899	103.9	94.6	97.7	101.7	96.1	101.1
1900	106.4	94.3	101.4	107.7	93.5	99.9
1901	111.0	94.4	103.2	117.9	116.8	105.7
1902	118.5	94.9	111.5	128.3	117.0	119.1
1903	112.9	101.2	110.8	127.0	114.8	125.3
1904	113.4	119.9	109.0	124.0	121.3	130.9
1905	112.9	119.9	112.7	120.6	110.2	131.6
1906	116.5	108.1	118.2	137.7	114.4	134.2
1907	120.6	117.7	127.6	142.5	120.6	137.7
1908	124.6	118.5	131.2	144.9	123.1	144.1
1909	138.3	120.4	134.7	143.8	124.9	142.5

It will be noticed that the results are practically the same. Prices have risen about a third.

Rents.

With regard to rents we have no comprehensive official data, while the alteration in building laws and other circumstances render comparisons difficult; but it is a well-known fact that during the past decade rents have slowly though steadily advanced. In our principal cities a class of apartments that ten years ago rented for $30 a month, now command $40. In the case of the better class of apartments, those which rented for $8 to $10 per room per month, now fetch $10 to $12; while the rooms themselves have grown smaller and the buildings higher. It is the opinion of an experienced manager of such estates that apartment rents in our principal cities have advanced during the last ten years from 15 to 25 per cent.

Clothing and Household Goods.

Comparing not the prices of, but the actual outlay for, clothing, hats, shoes, gloves, underwear, furniture, carpets, hangings, bedding and household goods at the present time, we find that there has been since 1897 a rise of 40 to 50 per cent, the articles of most common use varying from 35 to 45 per cent and those of less common use from 40 to 50 per cent advance over what they formerly cost to purchase or replace.

The Workingman's Food.

The official price table which exhibits the least advance is that of the cost of food consumed by 2,567 workingmen's families, each year from 1890 to 1907. This table does not include the cost of rent, clothing, hats, shoes, bedding, furniture, etc. The advance in the cost of food alone is shown to have been from $299.24 per family per annum in 1897, to $374.75 in 1907, a rise of about 25 per cent. This

may reasonably be regarded as a rise from 1897 to the present time of 28 to 30 per cent. As the American workingman usually lives very closely to the limit of his means, a rise of but 25 to 30 per cent in food expenditure, against a general rise of 35 to 40 per cent, rather indicates that the average rise in wages (union and non-union wage-earners combined) has not quite kept pace with the general rise in the cost of living.

Export Prices.

The statistics of domestic exports, which amount in the course of a decade to something like 15 billions of dollars and which are based on sworn manifests of each item separately, exhibit more striking results. Not to fatigue the reader with too many figures, we select a dozen leading articles from the export summaries and show their average prices during the entire years 1898 and 1908, the last mentioned being the most recent year shown in the official compendium of total comparative exports and their average prices. In this table the average rise of prices is close to 50 per cent. If it included exports of 1909 and 1910 it would exhibit a rise of over 50 per cent.

Export Prices of Twelve Leading Domestic Articles of Export from the United States During the Fiscal Years 1898 and 1908 Respectively.

Articles.	1898.	1908.
Boards, deals and planks, M. feet	$15.28	$23.00
Cotton, raw, pound	.059	.118
Cotton, manufactured, yard colored	.052	.072
Cotton, manufactured, yard uncolored	.048	.067
Bacon and hams, pound	.077	.109
Lard, pound	.056	.091
Pork, salted, pound	.056	.089
Beef, pound	.055	.068
Butter, pound	.15	.218
Cheese, pound	.086	.129
Leather, sole, pound	.175	.211
Boots and Shoes, pair	1.39	1.75
Together	$17,484	$25,922

This important table exhibits an advance of 50 per cent in prices.

The Fact.

Casting the view back to the period about the beginning of the present century, we find that wholesale prices have advanced about a third; retail prices of food, over a third; the average man's outlay for rents and services about a third; for clothing and household goods, over a third; the cost of the workingman's food (alone) about 30 per cent, and the prices of export goods (staples) alone, about one-half or 50 per cent; the general result being that, taking quantity, quality and numbers into consideration, the average cost of living

in the United States has risen about a third, with a decided tendency to still further advance.

Commodities and Dollars.

Reverting from the prices to the denominations in which they are couched, these are dollars and cents, the latter being portions of dollars. The method is quite correct; indeed there are no other terms in which they could be quoted, because all commodities are bought and sold for dollars. But in such quotations the important consideration is usually lost sight of: that while the commodities might be the same, one year with another, the dollars are *never the same*. The comparison is therefore scientifically inexact; in other words, the trend of prices shown in the price tables, is always erroneous in degree and may even be so in direction. Suppose we compare the purchasing power of a dollar in the time of Washington with its purchasing power to-day. Would any intelligent person claim that they were the same? In 1790, after the Continental issues were repudiated, and before the Bank of the United States was established, the population was about 4,000,000 and the number of dollars in use about 20,000,000, or say $5 per capita. There were no railroads to move these dollars rapidly from place to place, no bank notes to suppplement them, practically no banks to lend them out and keep them in circulation, no telegraphs to multiply their usefulness, and no clearing-houses to issue "certificate" dollars at a pinch. The only dollars in use were metallic ones; and each man kept his bank in his pocket, or in some secret hoard.

At the present time, with a population of 90,000,000, there are 3,104,547,273 dollars in circulation, amounting to $34.45 per capita (Treasury Statement May 2, 1910); to say nothing of the $500,000,000 of "emergency currency," all printed and stored ready for use in the United States Treasury building, or the "200 or 300 millions" of Clearing-House certificates which may be issued in case of another panic. Would any intelligent person claim that the dollar of 1790 and the dollar of 1910 was the same measure of value, the same criterion of price? Of course not. Nor has it it been exactly the same in any one of the intervening years, during which dollars were increasing from $5 to nearly $35 per capita of population.

Velocity.

There is another consideration to be borne in mind with reference to the dollars employed in comparative tables of prices: the more rapidly such dollars pass from hand to hand, in other words, the more often the same dollars can be used for payments in a given interval of time, the greater the influence they must exert in raising

prices. This is a function and peculiarity of money which is admitted and recognized by all the economists, a peculiarity which is well known to bankers and other dealers in money and which has been made the subject of numerous scientific researches, yet one which is rarely held in mind by the ordinary compiler of price-lists. Sixteen years ago (1894) as the result of an elaborate investigation into the phenomena of prices, the velocity of money in the United States was estimated at 52 times a year, or once a week, and in Great Britain at 180 times a year, or once in 2 days; a disparity that was found to be due chiefly to the relative geographical areas of the two countries. At the present time the velocity in the United States is probably not less than 60 times a year, or once in 6 days; in other words, that all the dollars in circulation in the country are used over and over again in payments 60 times during the year. How often the dollars of 1790 were used and re-used, we have no means of determining; but it will probably not be far wrong to estimate it at once a month. It would follow that the dollar of to-day was five times more rapid, useful and effective and therefore more influential in promoting trade and determining prices than the dollar of Washington's time. The bearing of this circumstance upon the common method of measuring the trend of prices from comparative tables, is obvious. It is that any comparison of prices, especially when made at distant dates, is scientifically erroneous, unless the quantity and velocity of money are both taken into consideration; for these, when multiplied into one another, form the practical measure in which such prices are couched. In the case of dollars which from any cause are imperfect, limited in legal functions, restricted in circulation, or liable to be hoarded or exported, certain allowances would have to be made; but for the sake of simplicity in endeavoring to discern the operation of a principle, we are assuming throughout full legal-tender gold dollars, in active circulation, within the country.

Assuming the total volume of the currency to be such as is above stated and the velocity at 60 times a year, the sum of exchanges ought to be $\$3,104,547,273 \times 60 = \$186,270,000,000$. That such is the fact, or very close to the fact, is proved by the actual sum of clearings, which, for the year ended September 30, 1909, was reported by the 123 clearing-houses of the United States at $\$158,500,000,000$. During the current year the clearings will probably amount to $\$175,000,000,000$, and allowing $\$11,270,000,000$ for exchanges that do not go through the clearing-houses, we have a grand total of $\$186,270,000,000$ of exchanges, to offset the sum of currency multiplied by its ratio of velocity. These figures afford strong evidence that the

theory of velocity is sound; and if so, it proves that, in considering the causes which have contributed to occasion a rise of prices, the increased and always increasing velocity of money, afforded by modern transportation, communication, and credit devices and agencies, should be taken into the problem. It would probably be hardly too much to say that, roughly speaking, fully one-tenth of the rise of prices during the past decade—whatever such rise may be—is attributable to the increased velocity of money, during the same period.

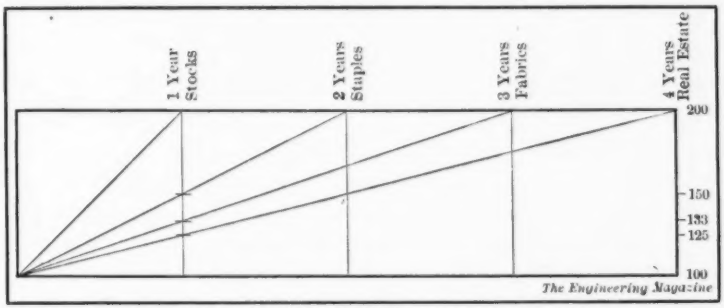
Precession.

There is yet another consideration, one to which no place appears to have been given in any of the essays which have been published on the subject of the rise in prices. It is this; that when any impulse is given to prices by increasing the currency, or accelerating its velocity and thus stimulating trade, all prices do not rise at the same time and therefore not at the same ratio at any given time. For the sake of illustration, let it be supposed that the number of dollars in circulation or their velocity were suddenly doubled and kept doubled. Other circumstances being equal, it would seem that the general level of prices ought also to double and to double instantly; but such is not the course of nature. It has been observed that under such an impulse, some commodities will rise in price more promptly and rapidly than others. For example, stocks will rise almost instantly, while real estate may remain unaffected until a much later period. From the observations referred to, covering a long period of years, it appeared that in the United States, following an increase of money and taking no account of the time involved in geographically distributing the increase, it nevertheless required a period of several years for all prices to conform to such increase. During this interval the prices of a certain few classes of commodities or services doubled, after which the prices of others doubled, and so on successively, until the doubling of all classes was completed. In other words, the doubling of prices was not simultaneous, but took the form of a Precession, the order of which was somewhat as follows:—1. Railroad stocks; 2, other stocks; 3, shares of commercial incorporations; 4, crude and imperishable commodities; 5, perishable commodities, articles of subsistence, etc.; 6, fabrics, such as machinery, manufactured food, articles of wear, etc.; 7, real estate; 8, skilled labor; 9, unskilled labor; 10, professional services, or the emolument of authors, inventors, lawyers, engineers, clergymen, accountants, and other professional and clerical classes.

The interval between the doubling of the prices in these various classes of commodities or services was not uniform; in other words,

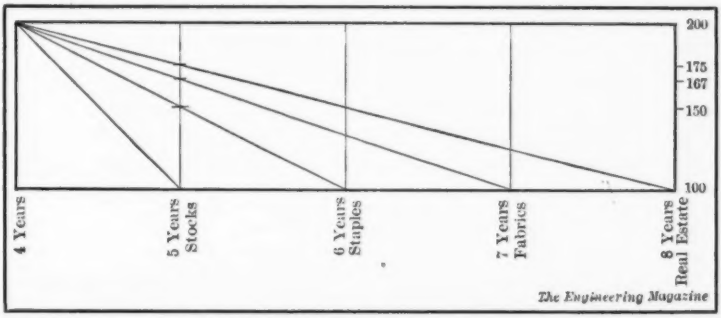
supposing four years to be the time required for the entire doubling of prices, and the classes of commodities and services to be four in number, it did not follow that each successive year added one to the classes with doubled prices. After once commencing to feel the effect of the increased volume or velocity of money, some classes of commodities doubled in price more quickly than others.

For the sake of a simple illustration, suppose this actual inequality to be ignored and each year to add one to the classes of commodities with doubled prices; then the following diagram would theoretically illustrate the rise of each class at the end of each year.



A. HYPOTHETICAL RISE OF PRICES FROM 100 TO 200.

Thus at the end of the first year stocks are at 200, staples 150, fabrics 133 1/3, and real-estate 125. At the end of the third year, while stocks have enjoyed for two years a continuous market at 200, fabrics have recently and barely reached the same high level, while real-estate is still a year behind. This phenomenon is further illustrated by the following diagram, which assumes that at the end of the fourth year the volume or velocity of the currency is suddenly reduced to its former level.



B. HYPOTHETICAL FALL OF PRICES FROM 200 TO 100.

The effect of rapidly enhancing the volume or velocity of the circulation per capita is to place fabrics and real-estate at a disadvantage as compared with stocks and staples; because while the latter rise rapidly in price, the former rise slowly. Contrariwise, when the volume or velocity of money is not urged too rapidly beyond the growth of population and therefore of legitimate business demands and exchanges, then the farmers, manufacturers, laborers, and other producers of fabrics, are enabled to maintain prices, while stocks have fallen and become cheap, and while marketed and speculative staples have begun to decline.

Although in summarizing so comprehensive a subject as the comparative cost of living at different periods of time it may not be practicable to apply concretely the operation of Velocity and Precession to tables of prices, it will hardly be disputed that they have both had some influence on the cost of living; velocity, by tending to enhance all prices, and precession, by advancing the prices of staples (as shown in the export tables) far beyond those of any other classes of commodities except stocks, which have enormously and notoriously advanced in price during the period in question.

Causes of the Enhanced Cost of Living.

Turning from the fact to the causes of the enhanced cost of living, the principal ones assigned by the various authorities who have examined the subject are as follows: 1, the tariff; 2, monopolies; 3, combination and "gentlemanly understandings" to enhance the prices of manufactures and farm products; 4, increased production of gold; 5, the demands of labor; 6, exhaustion of natural resources; 7, heightened standard of living; 8, extravagance of living; and 9, the congestion of population in cities.

With all respect to the authors of these researches, and after a careful examination of the causes alleged, some of which have undoubtedly contributed, and largely contributed, to occasion the rise of prices, we do not find that any of them, or all of them together, are sufficient to explain the whole extent of the rise.

Wealth, Earnings, and Savings.

According to official figures, the National wealth advanced from $88,500,000,000 in 1900 to $107,000,000,000 in 1904, an increase in capital of about $4,600,000,000 per annum. The annual volume of production was: Farm products, (corrected to) $10,000,000,000; minerals, $3,000,000,000; lumber, fish and miscellaneous, $1,000,000,000; and manufactures (net), $10,000,000,000; total, $24,000,000,000.

Of our 90,000,000 of population, 35,000,000 are employed in gainful occupations, of whom about 29,000,000 are males and 6,000,000

females. These numbers include about 2,000,000 of males and 500,000 female children, 10 to 15 years of age. Their united earnings amount to about $34,000,000,000 a year, their expenditures to not much less, say $30,000,000,000.

What has to be furnished is a cause or causes sufficient to explain a rise of about a third in the cost, to the consumer, of the commodities and services represented or indicated by these colossal sums. This consideration disposes at once of nearly all the alleged causes. The tariff last year yielded little over $300,000,000; the increased production of gold has nothing to do with prices unless the gold is coined into money and employed in the circulation. The increased amount so coined and employed is too trivial in comparison with the national measure of the cost of living to be worthy of consideration in this connection; the demands of labor are primarily and mainly a consequence rather than a cause of the enhanced cost of living; the heightened standard of living, the extravagance of living, and the economical effects of urban congestion are all included in the gigantic figures which form the base of the problem; the exhaustion of natural resources is offset by the discovery and utilization of new resources; while neither is sufficiently tangible to practically contribute anything towards a solution of the question.

There remain only two of the alleged causes to consider, and these are essentially one cause; the influence of monopolies, combinations and "understandings" made in restraint of trade, or with the object to maintain or enhance prices. There can be no doubt that among the causes alleged, this is the principal one; nor can it be disputed that the tariff, by creating or upholding monopolies, has largely contributed toward the rise. But we can only find an adequate explanation of the rise in two other causes, both of which are commonly left out of view in these discussions. These are the Total Weight of Taxation, and the Expansion of the Currency.

The Weight of Taxation.

In 1909 the Federal Government disbursed over $1,000,000,000. In 1902 (the latest official statistics) the various States, counties, cities, and towns disbursed $1,156,000,000, a rate of expenditure which by this time probably amounts to $1,500,000,000 a year, making the aggregate cost of government about $2,500,000,000. The Federal taxation to provide for these disbursements falls chiefly upon articles of consumption, and at least to that extent it enhances their cost and price; the State and local taxation falls chiefly upon lands, and houses, but largely also upon licences to trade, hence it enhances the prices of both rents and commodities. Two thousand

five hundred millions, or two and a half billions a year, together with the profits upon it (for nobody pays a dollar in taxes without endeavoring to more than equally recoup himself) form a heavy weight upon our thirty-four billions of annual earnings, and this weight cannot have failed to enhance very materially the cost of rents, commodities and services.

Solution.

The expansion of the currency, its increased influence upon prices due to velocity, and its varied enhancement of the different classes of commodities and services, such as stocks, staples, fabrics, real-estate, etc., enhancing certain of these classes more rapidly than others, due to precession, have already been shown. To estimate these dynamic influences in statical figures is impracticable; we can only claim generally that they are very considerable, and that together with the influence of an enormously expensive system of governments, Federal, State and local, they appear to be the only causes of a magnitude commensurate with the colossal nature of the problem.

The Future.

In relation to the productive, economical and fiscal operations of a great country, especially with those of the newest, the most extensive, and the most powerful State in the world, whose economic policy is necessarily subject to much experiment and change, it is extremely hazardous to predict. But if we permit our judgment to be guided by three or four great lines of national figures, which, ever since the foundation of the Republic, have exhibited a constant though not uniform rate of increment, the future level of prices, concretely the future cost of living, unless modified by a radical change of fiscal policy, seems almost inevitably bound to rise still farther. These lines of figures represent the steady growth of population; the steady growth of productive capacity; the steady increase of circulating money and the increase of the transporting facilities and credit devices which enhance its velocity; and the recent and enormous increases of taxation (federal, state and local,) which, from something less than one billion in 1897, has now reached two-and-a-half billions and is still pointing upward.

The future, as indicated by these lines, points to still higher prices. Nor can we regard such further rise as likely to be materially retarded by any of the otherwise laudable and well-meant acts of legislation which have been lately secured by our public men and representatives.

EDITORIAL COMMENT

The U. S. Bureau of Mines.

AS the creation of a Bureau of Mines under the Department of the Interior of the United States is an accomplished fact, any critical examination into the necessity for its existence might seem to be useless. In the judgment of most excellent authority, however, the bill by which the Bureau was created does not clearly define the plan nor scope of the Bureau itself nor the duties of its director. If as director is chosen a broad-minded man of technical training, who discerns clearly the policy under which the Bureau can do the most good, and who solves correctly the difficult problem of making the work under him co-ordinate and co-operative with that of the United States Geological Survey, the handicap of the political origin and character of the Bureau may be in a measure overcome. There is, therefore, still an opportunity for useful service in attracting the best professional interest in the country to the situation as it exists, and in inviting the expression of influential professional opinion, so that those who are to direct the work of the Bureau may see clearly the trend of thought among American mining men and take it into account in the establishment of their policies.

So far, one of the first and most perplexing facts connected with the movement is the extremely small part, if any, that has been taken by representative mining men, responsible mining interests, or the representatives of distinctive mining States, in the demand for the establishment of the Bureau, and the extremely small body of opinion, if any, among leading mining men affirmative of the *raison d'être* for the Bureau, now that it is here. The United States Geological Survey for years has been doing remarkable work in the only directions in which it seems possible for the Bureau of Mines to become active. The members of the Survey for the most part are men of high-grade technical training—such men as Emmons, Langren, Irving and Cross. Because of the high professional regard in which they are held by mine owners and managers, and because of the essentially scientific (as distinguished from political) purpose and temper of the Survey, its representatives have been given free access in their investigations of the mines of the United States, whether these investigations referred to geology, product, methods, or statistics. By their personal and professional character they have placed the work of the Survey on a high plane, and their publications have built up a reputation reflecting great credit upon the Survey and the Government. It is a matter of serious doubt whether mine owners and managers will be equally willing to afford to the members of this new Bureau (whose purposes are distinctively administrative, regulative, apparently a part of the inquisitorial and hostile attitude toward corporations which is now so popular) the freedom of access and investigation so readily given to the Technologic Branch of the Survey, by which the Government has been enabled to collect and distribute an enormous body of interesting data and statistics on the mining industry of the United States.

The bill by which the Bureau of Mines is created indicates as its principal purpose the prevention of accidents in mines. By far the most important function of the Bureau, therefore, will be the collection of such data and statistics as will guide the legislators to pass laws designed to secure the pre-

vention of casualties and fatalities, especially in coal mining. As it is now generally accepted that these accidents are traceable to certain conditions underground, which must be determined by the investigation of thoroughly trained scientists, capable of devising ventilation and other methods which will prevent explosions of gas or dust, it seems plain that the Geological Survey with its existing equipment has been working along the right lines. It is only, therefore, by bringing out the facts regarding mine explosions and mine accidents that anything can be accomplished by the Bureau; and the collection of these facts and statistics has long been done and is now being done most satisfactorily by the Survey.

It is very doubtful, therefore, whether the Bureau of Mines can do the work as well as the Survey has done it, except after many years of experience, or unless the two departments are drawn so closely together as to be practically under one head. But the bill itself divorces these two departments of the Government, and from its tone tends to convey the idea that they are to be completely separate, inasmuch as it specifically takes away from the Geological Survey certain "plant" which it is now using and turns over to the Bureau of Mines "such experts, employees, property and equipment as are now employed or used by the Geological Survey in connection with the subjects herein transferred."

Furthermore, a Bureau of Mines, which, as the bill expresses it, has to do with the methods of mining, especially with the safety of miners, is very likely to be accorded no more facilities than it can legally demand. It does not appear that it can accomplish anything, even in the direction sugested by the bill, that is not already achieved by the Survey. It does appear that as representing an administrative department of the Government and not a scientific one, its investigations will arouse a spirit of antagonism. And if reliance is placed upon statutory powers to obtain by force of authority that which will not be given it willingly, it seems that the objection advanced by Senator Root will certainly present itself—that is, that the Federal jurisdiction will be very small, the matters for the most part being subject to State and not Federal control; that the States will see in this Federal undertaking a duplication of the work already done by themselves; that they will not co-operate with the Bureau as they do with the purely scientific work of the Geological Survey; and that they will consider this undertaking by the general government an infringement of State rights.

These, then, are believed by well-informed men to be some of the difficulties which the Bureau will have to overcome—difficulties great enough to justify fully the suggestion hereinbefore made, that the directorship demands a high order of talent and a strong and efficient personality. Beyond these difficulties lie the problems of segregating the work of the Bureau from that of the Survey and still harmonizing both branches. And beyond that once more lie the difficulties of securing proper appropriations from Congress—difficulties from which the Survey has always suffered, but in spite of which its admirable work has been carried on. As the simpler course of strengthening the influence and enlarging the resources of the United States Geological Survey has not been adopted, but instead the machinery has been in part duplicated, and, it is to be feared, still more complicated by the creation of this new and anomalous institution, the Bureau of Mines, it rests with the wisdom of its director-to-be to make his fifth wheel as serviceable to the cause of progress as its somewhat unpromising nature and origin will permit.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE BRITISH RAILWAY SITUATION.

A SUMMARY OF THE INDICATIONS OF THE IMMINENCE OF GOVERNMENT OWNERSHIP AND THEIR LESSONS FOR THE UNITED STATES.

Engineering News.

WM. ACWORTH, one of the best posted railway men in Great Britain, in a paper contributed to the *Bulletin of the International Railway Congress* for February, examines the railway situation in Great Britain and finds many indications that great and fundamental changes impend. "The old edifice of the English railway system," he says, "is tottering to its fall, and no one yet knows what will take its place. The old system was one that relied almost wholly on private enterprise, the force of competition, that reduced state interference to a minimum, and, indeed, in the matter of facilities and public service practically excluded state interference altogether. This system is passing away. In the proximate future we shall have to choose between state-regulated monopoly or, as to me seems much more probable, state ownership and state operation."

Mr. Acworth's paper is reprinted in full in *Engineering News* for May 19. An editorial in the same number, from which we quote at length below, summarizes his arguments and indicates the lessons which the railways of the United States may learn from the present situation in Great Britain. It is pointed out that "the railway system of the United States is patterned closely after that of Great Britain. In the other great nations—Germany, France, Russia, Austria—government ownership of railways is the rule. Government ownership is the rule, too, in most of the minor countries; and in some countries which have not adopted government ownership, the Government is actually closely concerned with railway operations through the grant of government subsidies. It is, broadly speaking, true, therefore, that Great Britain and the United States are the only two great nations of the world which have developed their railway systems by private enterprise alone and which have never in any degree adopted government ownership of railways.

"In both England and the United States, government supervision of railway operation has been steadily increasing during the past quarter century. In England, however, competition in railway transportation has been maintained to a much greater extent than in the United States, and has been a chief reliance in securing for the public reasonable rates and efficient service. But there is now impending in England an era of consolidation and combination which promises to put an end to competition. To appreciate the importance of Mr. Acworth's statement quoted above, it should be understood that Mr. Acworth is not only one of the best informed men in British railway circles, but is and always has been one of the strongest advocates of pri-

vate railway management as opposed to government ownership or control.

"The causes which have brought about this impending change in the British railway situation are fully set forth by Mr. Acworth. Briefly summarized, British railway managers are between the devil and the deep sea. On the one hand, their employees demand better wages and better conditions. In 1907, under the imminent prospect of a general railway strike covering the entire country, the railway managers were obliged to submit to arbitration questions relative to wages and hours of labor. On the other hand, there is strong complaint from freight shippers that the rates charged are too high, and strong pressure has been exerted through the British Board of Trade to bring about a reduction. And with this pressure to increase expenses and reduce earnings comes vigorous complaint from shareholders, who complain of scanty profits and low rates of dividend. Under the stress of this situation, competition in the railway business, so long maintained in England, broke down. Combinations were arranged between the different great railway companies which would have assembled all the lines into three or four non-competitive groups. It was hoped by this plan to reduce the heavy expenses caused by competition and thus enable the companies better to meet the demands of employees, shippers and stockholders. But when the sanction of the Government was sought for these combinations, great public protest was made and the desired consent was refused. Actual consolidation, therefore, could not be carried out; but a similar end could be and has been attained through private agreement. As Mr. Acworth tersely puts it, 'competition in fact is dead, and not all the king's horses nor all the king's men can bring it to life again.' With competition ended, as a force in securing to the public good service at reasonable rates, it is undoubtedly true that England must choose between a long step forward in government control of railway operations and the adoption of state ownership and state operation.

"Turning, now, to the situation in the United States, it is probably true that the general public at present regards government ownership of railways as a mere dream of the theorist. While such a policy might perhaps find considerable popular support, the business community undoubtedly would almost unanimously oppose it. But how long is the public likely to retain this position? We cannot safely shut our eyes to what is going on about us in other countries of the world. Within the past two years, Japan and Mexico have each undertaken the complete nationalization of their railway systems. Unquestionably the tendency is in this direction, the world over. If Great Britain should take the step which Mr. Acworth declares to be probable, the United States would be left as the only country in the world having its railway system entirely under private management.

"It is of interest to inquire as to the causes which have brought British railways into the unfortunate situation which Mr. Acworth describes. It is a historical fact that when George Stephenson's great success with the locomotive inaugurated the railway era, the railway was regarded as chiefly a means of passenger transportation. The early railway promoters had no idea of competing with the canals in the carriage of coal and other low-class freights, their ideas were directed solely toward the carriage of passengers at high speeds. The railway system of England, which was developed earlier than that of any other country, was particularly planned and has always been particularly operated, with passenger traffic as its main object. English railway men appear to have been slower than those of other countries to appreciate the fact that freight traffic rather than passenger traffic was the business paying greatest profits.

"In the profitable handling of passenger traffic, moreover, English railways have always been hampered by the great handicap of the class system. The

necessity of providing first, second and third-class accommodations in practically every passenger train was modified only a few years ago by the abolition of the second class on most English railways. The first-class and third-class, however, still continue in use everywhere. The system of classing passenger traffic, in conjunction with the use of the compartment system for passenger cars, makes it exceedingly difficult to load passenger trains to anything like their capacity. A large proportion of English passenger trains run with their seats not one-third filled. More important than this, in its effect on operating expenses, however, is the great number of station men which are necessary on account of the compartment system. While the wages of these men are very low according to our American standards, the number of employees is so great that the burden upon railway operating expenses is extremely heavy. It will be admitted, of course, that the English system of handling passengers is so imbedded as one of the customs of the country that any radical change would be extremely difficult. Nevertheless, it is apparent that reduction of operating expenses is one of the first essentials to placing English railways on a proper financial basis, and the most direct means of reducing operating expenses is reduction in the number of trains and in the number of employees.

"The second great handicap under which English railway companies labor is their enormous capitalization. Fortunately, this capitalization is in stock or debenture securities not subject to foreclosure. English railways, therefore, do not have to meet interest on mortgage bonds under the penalty of going into a receiver's hands. What does face them is general dissatisfaction on the part of their security holders because of the low rates of dividend. Under present conditions, however, net earnings would have to be very largely increased to raise materially the rate of return to holders of railway securities, because the capitalization per mile is so heavy. The average capitalization of all the railways of Great Britain is about $270,000 per mile, which compares with about $75,000 per mile in the United States.

"There are several reasons for the high capitalization of British railways. The first is the high class construction which has prevailed everywhere in England since the earliest days of the railway era. More important than this, however, is the very heavy expense which the railways were under to obtain terminal facilities in the cities which they entered. Ranking almost on a par with this are the very heavy parliamentary and legal expenses with which the railway companies were burdened in securing their franchises. Besides all these, the policy has always been in Great Britain to charge all expenditures on improvements to capital account. Where American railways have devoted a certain proportion of their earnings to betterment British railways have conscientiously capitalized every expenditure which could not be classed as repair or maintenance. As a consequence, their capital has gone on rolling up like a huge snowball until the present stupendous figures have been attained.

"While such a system of capitalizing expenditures on betterments may have a theoretical justification, it is inherently unsound. Take, for example, the very large fees paid to the experts who appeared before Parliament in obtaining the charters of some of the early railway lines. Because a company paid $50,000 to Robert Stephenson for his testimony before a Parliamentary committee 75 years ago, is it reasonable that the public should go on paying interest on that expenditure, not only for the 75 years that have elapsed since, but for untold centuries to come? Does not any such system of capitalization tend to break down by its own weight? Ought not a certain proportion of earnings to be annually set aside for the retirement of capital, or, what amounts to the same thing, for expenditure upon betterments, instead of charging them to capital account?

"It has seemed to us important to call attention to this situation with respect to the railways of England because of the temptations now present to the railways of our country to repeat the same mistakes here that have been made there. American railway companies during the past ten years have been increasing their capitalization in a manner wholly unprecedented. Improvements of all sorts are paid for with a lavish hand so long as Wall street will purchase stocks or bonds and when these are unsalable, short-term notes are resorted to. Wherever the improvements to be made with this money will actually pay for themselves in the shape of reduced expense of operation or increased earnings, such added capitalization is, of course, justifiable, but if the secrets of all hearts were revealed, we fear that no small proportion of this added capital would be found invested in directions which promise small returns in the way of revenue and which will benefit the banking interests in control rather than the stockholders of the present or future.

"We believe that in many respects the railway system of the United States under private management, and with the benefit of private initiative, is superior to the railway system of any other country. But if we are to continue to have these benefits—if the United States is not eventually to follow the example of all other nations by adopting government ownership for its railway system—then our railway magnates must realize their trusteeship in the largest sense. They must be willing to learn from the experience of other countries; they must be as ready to recognize the rights of the public and of their employees as they are to see the opportunities to make fortunes through the promotion of big deals and a vast outlay of money in extensions."

CONCRETE BARGES ON THE PANAMA CANAL.

DETAILS OF THE DESIGN AND CONSTRUCTION OF THREE REINFORCED-CONCRETE BARGES FOR THE SUPPORT OF DREDGING PUMPS.

Engineering Record.

OUR issue for May of last year contained a brief description of reinforced-concrete barges and pontoons built in Italy by the pioneers in this branch of naval construction. While reinforced concrete has been applied to this purpose only in isolated cases, builders and users of concrete barges are agreed that the material lends itself well to this new use and, under certain conditions, is superior to wood or steel. A combination of circumstances recently led to the adoption of reinforced concrete for the construction of three barges for the support of dredging pumps on the Pacific Division of the Panama Canal. The barges had to be ready for service at short notice, and neither materials nor men were available for their construction in wood or steel. The cost of material for one barge was estimated at $1,065.80, which compared favorably with the cost of any other barge of the size desired. The results obtained with the first barge, which was launched on April 19 last, 60 days after the commencement of work, have amply justified the choice of material.

A description of the design and construction of this barge is given in *Engineering Record* for May 28. "It is rectangular in plan, 64 feet long, 24 feet wide, and has a 7-foot rake at the bow and stern to facilitate towing. The bottom is flat, while the deck has a sheer lengthwise of 4 inches and 1-inch crown crosswise, so that the depth of the hull varies from 5 feet 4 inches to 5 feet 8 inches.

"Two bulkheads, 3 inches thick and spaced 8 feet on centers, extend from bow to stern, forming, with the 2½-inch side walls, three equal compartments. The bulkheads and side walls, stiffened at intervals of 10 feet by posts 10 inches

square, are each to be considered as the web of a girder, whose chords are formed by a line of longitudinal 10 and 11½-inch beams in the deck and floor of the barge respectively. At the posts, the top and bottom chords of the girders are cross-connected by 10 and 11½-inch beams with heavy kneebraces. The system of beams subdivides the deck and bottom into 8 by 10-foot panels, which are covered by 3-inch and 2½-inch slabs respectively.

The following reinforcement is being used: In the bottom slab, ½-inch mesh No. 12 wire cloth and ½-inch square bars, spaced 12 inches on centers crosswise and 9 inches lengthwise. The same reinforcement is used in the 2½-inch side walls. In the deck ½-inch square bars are spaced 8 inches crosswise and 6 inches lengthwise. Deck and bottom beams have the same reinforcement, viz.: three ¾-inch square bars on the tension side, one of which is bent up at the quarter points and carried over the supports. The posts are reinforced by four ¾-inch square bars, 2 inches from the corners, the kneebraces by two ½-inch bars, while ½-inch square bars are placed vertically and spaced 8 inches on centers on the longitudinal bulkheads.

"Six round 21-inch hatches are provided, one at each end of the three compartments, to give access to, and allow inspection and ventilation of, the interior. Wherever a hatch is located, the slab is strengthened by an additional small beam. Near each corner of the deck a mooring bit is anchored by six ¾-inch countersunk bolts through the slab to a heavy washer plate. A 12 by 6-inch timber fender is fastened flush with the deck to the sides and ends of the boat." The total of the dead and live loads is 288,500 pounds. The displacement light is 3,678 cubic feet, and loaded, 4,624 cubic feet, making the draft of the barge light, 2 feet 9 inches, and loaded, 3 feet 5 inches.

In building the barge, "a platform was built on cribbing with enough height underneath for men to work and to build the ways for launching. On this platform sheets of wire cloth are laid crosswise and bent up so as to extend the total height of the side walls. The sheets are 36 inches wide and are securely tied together where they butt in the length direction of the barge. On this wire cloth are tied the bars that form the reinforcement of the bottom. The cross-bars are made up of one piece 14 feet and one 22 feet long, spliced by overlapping 1 foot, the splice being alternately under the port and starboard length girder. Five feet at each end of these bars are bent up and form the reinforcement of the sides. The longitudinal bars consist of 21-foot pieces, spliced at every second cross-beam by overlapping 1 foot; the splices are staggered. At the ends of the barge these bars are bent up to conform to the outline of the rakes. The arrangement of the longitudinal bars in the side walls is similar. At the center lines of all beams stirrups are hooked to the main bars; they are 5/16-inch rods, spaced 9 inches on centers for the longitudinals and 12 inches for the cross-beams.

"The concrete shell is formed by plastering the steel skeleton. For that purpose the reinforcement is suspended on wooden beams, sections 10 by 24 feet at a time, and the sheeting of the platform is removed. The plaster can be applied from the outside and pressed well into the wire mesh. As soon as the initial set takes place a high finish is given to the lower face, and finally, the supporting platform is put back in place. The progress is so arranged that a day's work ends under a line of cross-beams and takes in the whole width of the bottom. After this first coating, about ½ inch thick, has set for three days, the plastering of the inside is started. Here the joint between two days' work is located half way between two lines of cross-beams. The plastering of the sides is performed in a similar manner. To make the mortar set faster, thereby facilitating the plastering, and to produce a denser mixture, one-quarter of the cement has been replaced by lime.

"Next the forms for floor-beams are erected, and the steel for floor-beams, posts, kneebraces and bulkhead placed. This done, the floor-beams can be con-

creted. Then the forms for posts, bulkheads, deck beams and deck slabs are put up, the beam and slab reinforcement laid and tied. The longitudinal bars in the deck are 21 feet long, and have their splices arranged like the bars in the floor; the cross-bars are 26 feet long and have 14 inches at each end bent down into the side wall. In laying concrete a day's work is stopped for the beams, in the middle of a span; and for the slabs, at the center line of a beam.

"All forms were built in sections, the pieces being small enough to pass through the hatches, and the same forms will be used for all three barges. From the start, concrete was protected by heavy canvas against the hot sun, and was kept moist by sprinkling with a hose."

THE CHOICE OF MOTORS FOR MACHINE TOOLS.

A SUMMARY OF STANDARD PRACTICE IN THE SELECTION OF ELECTRIC MOTORS FOR MACHINE-TOOL DRIVING.

Charles Fair—American Institute of Electrical Engineers.

IN our last issue we printed in these columns a series of tables giving standard sizes and speeds of motors for driving various classes of machine tools. A useful supplement to these data will be found in the table below, taken from a recent paper by Charles Fair before the American Institute of Electrical Engineers and printed in the *Proceedings* for May, which summarizes standard practice in the choice of the type of motor for machine-tool applications. The difficulties of selection, Mr. Fair thinks, have been greatly exaggerated. Various circumstances may call for radical departures from standard practice, but under average conditions the list given may safely be followed.

In general, shunt-wound motors are used when the work is of a fairly steady nature, when considerable range of speed adjustment is required, on group and lineshaft drives, etc. Compound-wound motors are used where there are sudden calls for excessive power of short duration. Series motors should be applied where speed regulation is not essential and where excessive starting torque and low starting speeds are required.

The alternating current motor of the squirrel-cage rotor type corresponds to the constant-speed, shunt, direct-current motor, but with a high-resistance rotor it approaches more closely the characistics of a compound direct-current motor. The variable-speed machines, placed in the list under the alternating-current squirrel-cage rotor column, are understood to have the necessary mechanical speed changes. The slip-ring induction motor with external rotor resistance would be used for variable speed, not as corresponding to the direct-current adjustable-speed motor, but to the direct-current shunt motor with armature control. The self-contained, rotor-resistance type would be used for lineshaft drives and for groups of sufficient size.

Mr. Fair is emphatic as to the choice of standard motors. "One of the most important features in the selection of motors and one that is persistently overlooked," he says, "is the strict adherence to the use of standard motors, and by standard motors is meant standard armature shafts as well. The importance of maintaining standard armature shafts will be readily recognized by the factory management when it is pointed out that by such an arrangement spare armatures are reduced to a minimum, and that in an emergency it is possible, where these are not carried, to replace an armature or even a whole motor, from an idle tool, or from a tool of relatively less importance at the time. Also, of course, stock motors can be supplied promptly by the manufacturer and shipments materially improved if special shaft extensions are not called for. That special features in a motor are sometimes desirable, is not to be denied; it may so happen that the ad-

MOTORS FOR MACHINE TOOLS.

Tool.	Direct current. Shunt.	Compound.	Series.	Alternating current. ×	#	*
Bolt cutter	†			×		
Bolt and rivet header		40 per cent.				
		20 per cent.		×	#	
Bulldozers		40 per cent.			#	
		20 per cent.		×	#	
Boring machines	†			×		
Boring mills	†			×		
Raising and lowering cross rails on boring mills and planers		60 per cent.	†		#	
Boring bars	†			×		
Bending machines		20 per cent.		×	#	
		40 per cent.				
Bending rolls		40 per cent.	†			*
		80 per cent.				
Corrugating rolls		20 per cent.		×	#	
		40 per cent.				
Centering machines	†			×		
Chucking machines	†			×		
Boring, milling and drilling machines	†			×		
Drill, radial	†			×		
Drill press	†			×		
Grinder—tool, etc	†			×		
Grinder—castings		20 per cent.		×		
Gear cutters	†	20 per cent.		×		
Hammers—drop		20 per cent.			#	
		30 per cent.				
Keyseater—milling—broach	†			×		
Keyseater—reciprocating	†	20 per cent.		×		
Lathes	†			×		*✣
Lathe carriages			†		#	
Milling machines	†			×		
Heavy slab milling	†	20 per cent.		×		
Pipe cutters	†			×		
Punch presses		20 per cent.		×	#	
		40 per cent.				
Planers		20 per cent.		×		
Planers—rotary	†	20 per cent.		×		
Saw—small circular	†			×		
Saw—cold bar and I beam	†	20 per cent.		×		
Saw—hot		20 per cent.		×		
Screw machine	†			×		
Shapers	†	20 per cent.		×		
Shears		20 per cent.		×	#	
		40 per cent.				
Slotters	†	20 per cent.		×		
Swaging		20 per cent.		×	#	
Tappers	†			×		
Tumbling barrels or mills		20 per cent.		×		

× Squirrel-cage rotor.
Squirrel-cage rotor, high starting torque.
* Slip-ring induction motor with external rotor resistance.
✣ Might be used for tire lathes, as it allows slowing down when cutting hard spots.

vantages from some special feature in the motor may more than offset the disadvantages above referred to, but in cases where these special features are thought necessary they should be carefully considered before a final decision is made."

THE COST OF ELECTRIC POWER IN NEW YORK CITY.

AN ANALYSIS OF THE GENERATION AND DISTRIBUTION COSTS OF TWO LARGE POWER COMPANIES FOR THE YEAR ENDING JUNE 30, 1907.

Engineering-Contracting.

THE tables following, which are compiled from two articles published in *Engineering-Contracting* for April 6 and May 11, give authoritative unit costs of generating and distributing electricity for power and lighting in the plants of the Edison Electric Illuminating Company of Brooklyn and the New York Edison Company. during the fiscal year ending June 30, 1907. The New York Edison Company produces nearly 70 per cent. of the electricity used for lighting in New York City and the Brooklyn company is by far the most important operating in the city, next to the New York Edison Company. The com-

Generation and Distribution Equipment.

Station Equipment.

	Brooklyn. Number.	Brooklyn. Capacity.	New York. Number.	New York. Capacity.
Generating plants	1	23,650 kw.	8	108,300 kw.
Boilers, water tube	40	23,400 hp.	144	76,382 hp.
Superheaters	8	6,000 hp.	45	29,250 hp.
Steam engines, direct connected	5	14,750 hp.	30	82,900 hp.
Steam engines, belted	..	....	5	1,725 hp.
Turbo-units, direct current	2	11,250 kw.	..	....
Turbo-units, alternating current	..	....	9	53,500 kw.
Generators, direct connected, a. c.	5	12,400 kw.	21	93,000 kw.
Generators, direct connected, d. c.	..	....	34	14,100 kw.
Generators, belted, a. c.	..	....	3	900 kw.
Generators, belted, d. c.	..	....	2	300 kw.
Boosters	1	50 kw.	..	....
Exciters, motor-driven	2	250 kw.	10	1,400 kw.
Exciters, steam-driven	2	1,000 kw.	3	225 kw.
Storage battery cells	222	5,120 ah.	2x140	12,000 ah.
Rotaries	1	1,000 kw.	..	....
Transformers	3	1,200 kw.	2	2,500 kw.
Frequency changers	..	....	1	1,000 kw.

Substation Equipment.

Substations	..	....	23	93,750 kw.
Rotary converters, etc	63	29,600 kw.	100	93,750 kw.
Transformers	156	43,500 kw.	276	108,735 kw.
Storage battery cells	1,200	18,875 ah.	32x150	192,000 ah.
Balancers	7	450 kw.	..	....
Boosters	13	650 kw.	..	....
Motor generators	31	8,045 kw.	..	....

Cost of the Brooklyn Plant.

	Total.	Per kilowatt.
Generating station buildings and land	$ 674,666	$ 29
Substation buildings and land	650,559	28
Other real estate	48,007	2
Steam plant, generating station	1,051,796	44
Electrical plant, generation station	965,824	41
Substation apparatus	507,965	21
Transmission lines	4,136,009	175
Construction, subways	230,950	10
Services	973,558	41
Line transformers	150,184	6
Meters	301,677	13
Arc lamps	242,607	10
Tools and implements	20,955	1
Office furniture and fixtures	50,131	2
Miscellaneous appliances	64,874	3
Storage batteries	182,150	8
Sundries, automobiles, etc	74,526	3
Total	$10,326,437	$437

bined capacities of the plants of the two companies aggregate nearly 132,000 kilowatts.

The total first cost and the first cost per kilowatt of rated capacity of the Brooklyn plant are given in the tables. No exact figures of the cost of the New York plant are available, but the records show that $43,417,883 of bonds have been issued. This probably represents the actual engine cost, about $400 per kilowatt. It is possible that additions, paid for out of earnings, have increased the cost to $500 per kilowatt. The cost of the United Electric Light and Power Company's plant in New York, comprising four generating stations with a combined capacity of 10,200 kilowatts, was $523 per kilowatt.

Meter, Lamp, Conduit, and Wire Equipment.

	Brooklyn.	New York.
Meters owned	18,088	74,169
Meters in service	16,011	70,533
Lamps owned:		
A. C. enclosed arc	577	1,957
D. C. enclosed arc	6,352	13,806
D. C. open arc	1,174	...
Nernst	2,711	1,813
Glowers	...	6,522
Lamps in service, arc	...	34,531
Lamps in service, incandescent	...	2,665,085
Conduits owned, duct feet	3,039,132	...
Conduits occupied:		
Duct feet occupied	2,355,177	4,461,600
Feet of circuit, d. c.	1,495,057	10,183,000
Feet of circuit, a. c.	810,354	1,000,000
Million mil. feet of wire, d. c.	1,558,042	4,619,000
Million mil. feet of wire, a. c.	472,781	179,000
Overhead lines:		
Feet of circuit, d. c.	918,348	...
Feet of circuit, a. c.	513,892	1,096,000
Million mil. feet of wire, d. c.	81,125	...
Million mil. feet of wire, a. c.	86,443	794,000
Feet of street occupied	875,918	639,735

Production and Sale of Current.

	Brooklyn.	New York.
Kilowatt-hours produced	71,769,804	299,172,421
Kilowatt-hours used in station	800,783	.....
Kilowatt-hours sold	[illegible]	260,024,092
Average load factor	34.7 per cent.	31.5 per cent.
Transmission losses, etc.	32.5 per cent.	30 per cent.
Average sale price, cents per kw.-hour	6.6	6.49

The tables give unit cost per kilowatt-hour produced. The costs per kilo-

COST OF POWER GENERATION AND DISTRIBUTION.

PRODUCTION EXPENSE.

	Brooklyn. Total.	Brooklyn. Cents per kw.-hour.	New York. Total.	New York. Cents per kw.-hour.
Salaries	$22,510	0.031	$35,908	0.012
Labor	136,116	0.190	508,778	0.171
Fuel	285,654	0.400	1,210,599	0.406
Oil, waste and sundries	17,355	0.024	54,565	0.018
Water	28,449	0.039	135,211	0.045
Repairs, buildings and structures	2,493	0.003	37,435	0.012
Repairs, motive power	39,622	0.056	211,175	0.070
Repairs, electrical apparatus	2,296	0.003	22,634	0.007
Station expense	2,330	0.003	24,893	0.008
Purchased power, electric	28,575	0.039	75,220	0.025
Total production expense	$565,400	0.788	$2,316,418	0.774

DISTRIBUTION EXPENSE.

Salaries	$7,687	0.011	$64,146	0.021
Substation labor and expense	98,607	0.138	148,499	0.050
Rental of conduits, etc.	117,162	0.163	1,014,081	0.339
Incandescent lamp renewals	110,199	0.153	538,213	0.147
Wiring and jobbing	.....	....	139,713	0.047
Repairs, poles and lines	22,918	0.032	21,716	0.007
Repairs, subways and cables	30,957	0.043	56,856	0.019
Repairs, meters	4,872	0.007	221,894	0.074
Repairs, transformers	187	....	.....	....
Repairs, substations	.....	....	202,611	0.068
Repairs and expense, commercial lamps	89,711	0.125	12,872	0.004
Repairs and expense, street lamps	.....	....	68,096	0.023
Total distribution expense	$482,300	0.672	$2,388,698	0.799

GENERAL EXPENSE.

Salaries of officers	$18,850	0.029	$51,241	0.017
Salaries of office staff	67,665	0.094	335,825	0.113
Collecting and reading meters	19,797	0.028	.....	....
Office expense	.....	....	294,009	0.098
Legal expense	19,009	0.027	116,630	0.039
General expense	73,256	0.101	.....	....
Advertising and soliciting	.....	....	218,850	0.073
Advertising	44,364	0.061	.....	....
Canvassing new business	82,917	0.115	.....	....
Insurance	47,884	0.067	118,393	0.040
Engineering and testing	.....	....	78,707	0.026
Leaseholds, rentals, etc.	.....	....	47,656	0.016
Miscellaneous	58,178	0.080	.....	....
Total general expense	$431,920	0.602	$1,262,311	0.422
Taxes, general	$86,916	0.121	$702,628	0.235
State franchise tax	61,584	0.085	.....	....
Leaseholds, rentals, etc.	4,783	0.007	.....	....
Uncollectable bills	.....	....	35,464	0.011
Depreciation and contingent expense	.....	....	1,721,413	0.575
Grand total	$1,632,903	2.275	$8,425,933	2.816

watt-hour sold in Brooklyn and New York were, respectively, 3.37 cents and 4.04 cents. The costs of repairs per kilowatt of rated capacity in the Brooklyn and New York plants were, respectively, $4.36 and $8.37 exclusive of lamp renewals, and $12.80 and $12.83 including lamp renewals. Allowing 4 per cent. of the first cost of the Brooklyn plant for depreciation and 6 per cent. for interest on the invested capital, the cost per kilowatt-hour sold becomes 5.498 cents. The average selling price was 6.6 cents per kilowatt-hour; hence the net profit was at least 1.1 cent per kilowatt-hour. Interest at 6 per cent. added to the cost per kilowatt-hour in the New York plant increases it to 5.60 cents. At an average selling price of 6.49 cents, the net profit was nearly 0.9 cents per kilowatt-hour.

The employees of the New York company numbered 4,014 and their average wage was $16.40 per week. The average wage of the 1,454 employees in Brooklyn was $13.50 per week. The coal burned in both plants was nearly all anthracite of a very low grade. Coal consumption per kilowatt-hour was 4.30 pounds in Brooklyn and 4.11 pounds in New York. The average prices of the fuel in the two plants were, respectively, $1.60 and $1.96 per ton of 2,000 pounds.

MODERN METHODS OF LIGHTNING PROTECTION.

A BRIEF REVIEW OF METHODS AND APPARATUS FOR THE PROTECTION OF LINE AND STATION EQUIPMENT.

Charles P. Steinmetz—The Central Station.

PROTECTION of electrical systems against the disturbances produced by atmospheric electricity and internal phenomena of the same nature has become almost wholly an economic problem. Modern science has elucidated the causes of the troubles which were once the despair of the electrical engineer and has provided methods and apparatus by which it is possible perfectly to protect an electrical system against lightning. With adequate means of protection at hand, the engineer of to-day has only to balance the increased cost of installation and operation of the system equipped with lightning protection against the higher order of reliability which the protection confers. Reliability of service, however, as a factor in successful operation, has increased rapidly in importance with the extension of transmission systems to cover larger and larger areas and to transmit currents of higher and higher tension, and the protection of systems against lightning disturbances is in most cases a matter of considerable moment.

Dr. Charles P. Steinmetz has given in *The Central Station* for May a brief review of the modern methods and apparatus for the protection of line and station equipment against both external and internal lightning. External or atmospheric lightning is almost always momentary, a single high-voltage impulse or a few impulses in very rapid succession. Internal lightning is frequently continuous, high-voltage impulses following each other in rapid succession sometimes for hours or even days. Momentary high-voltage impulses are produced externally when lightning strikes the line or occurs sufficiently close to induce in the line a voltage impulse; internally they may result from switching operations, short circuits, sudden change of load, etc. A stroke of atmospheric lightning, depending on its power, may shatter several poles and insulators or merely run along the line as a wave of rapidly decreasing intensity. Momentary internal lightning is rarely of serious danger because of the protection which modern switching and other apparatus, designed to reduce shock to a minimum, give the system. The most frequent causes of continuous lightning, in which much more danger lies, are arcing grounds, flaring arcs, spark discharges, etc., in cable systems or high-voltage overhead lines of considerable capacity.

The problem of lightning protection involves both line and station apparatus. External lightning may be excluded from the system by protection of the lines, through which it almost always enters the system. Internal lightning may originate in the lines as well as in the station apparatus. Theoretically complete protection of an overhead line against the entrance of atmospheric disturbances may be obtained by enclosing the line in a grounded shell of high conductivity. An approximation to this protection is afforded by an overhead ground wire of good conductivity, carried above the line wires at such height as to bring the line wires at least 45 degrees below the ground wire and grounded preferably at every pole. Frequency of grounding is of far greater importance than low resistance.

The protection afforded by the ground wire will practically always warrant the additional expenditure required to instal it, except in systems where reliability is of no importance or in regions where thunderstorms are of very rare occurrence. Additional protection can be obtained by installing an additional ground wire on either side of the line, but such an installation is rarely warranted except in sections especially exposed to lightning. Where a ground wire is used, it is desirable to supple-

ment it by a short lightning rod at each pole. Lightning rods at each pole are occasionally used in place of the ground wire. While they offer some protection against direct strokes, they are practically no protection against induced discharges from the clouds. The installation of a lightning rod every five or ten poles offers no protection whatever.

The most effective line protection is afforded by construction with a very high margin of safety, readily obtained by the use of the suspension insulator, the invention of which marked a distinct and important advance in high-tension line construction. Lines equipped with this device have been remarkably free from lightning troubles, even when not protected with ground wires.

Disturbances in the line produced by lightning rapidly diminish as they pass along the line. The farther away from the station the disturbance enters the line, the less danger it offers to the station equipment. Hence, in cases where overhead ground wires are not used over the entire line, some improvement in station protection results from covering the line for one-half mile to one mile from the station with ground wires. The final protection of the apparatus in the station, however, must be left to the station lightning arrester.

"The requirements of the lightning arrester are, that it afford a path from the line to ground at moderate over voltage, that this path be of unlimited discharge capacity, that is, afford no appreciable resistance or inductance to the discharge, and that the discharge shall not result in any disturbance of the system, which might cause high voltages and thereby damage elsewhere, and should not produce a short circuit on the system. The latter two requirements are apparently contradictory: the lightning arrester should freely pass the lightning discharge, but should not pass the main current, which tends to follow the discharge as short circuit, and the difficulty of the problem of lightning-arrester design consists in combining these latter two requirements.

"The three existing types of lightning arrester are the single gap, the multigap, and the aluminium cell. The single gap is very largely used in low-voltage circuits, combined with a blow-out magnet in direct-current railway circuits. Sometimes it contains a mechanical device to open the gap after the discharge. The latter obviously has the disadvantage that, if a second discharge follows immediately after the first, it may find the arrester gap still opened, and the protection thereby absent. In high-voltage circuits the single gap is always developed as a horn gap; that is, the two terminals are curved back so that the arc, rising between them, lengthens and thereby gradually blows itself out. The horn gap has the advantage of simplicity, but the disadvantage, when used without resistance in series thereto, that it short circuits the system for an appreciable time, sufficiently long to throw all synchronous apparatus out of step and frequently have the generators break synchronism, and its discharge in large alternating systems thus commonly results in a shut down. Furthermore, a long flaring arc is extremely vicious, as it produces high-frequency, high-voltage oscillations, so-called internal lightning, and the result of its discharge thus may be more disastrous than the lightning against which it attempts to protect. With a resistance in series, the line disturbance caused by the discharge is reduced, and the main current, which follows the discharge, is limited so as not to cause a short circuit. At the same time the discharge current is equally limited, and with a high-power lightning dsturbance the resistance gap fails to protect. Horn gaps therefore are rarely used as station arresters, and then only as emergency devices under conditions where a shut down is accepted as unavoidable. They must, however, never be used without resistance in cable systems, as with the high capacity of cables they produce destructive oscillations.

"The multigap in its most perfect design comprises a considerable number of small gaps in series with each other,

between corrugated brass cylinders. It contains no resistance in series, and thus affords unlimited discharge capacity, but comprises several shunt resistances, usually a high resistance, a medium resistance, and a low resistance, and thereby affords a selective path, according to the power of the discharge; that is, discharges with the minimum shock on the system. The main current, following a very high power discharge over the path of no resistance, short circuits the system, but the short cirsuit lasts only up to the end of the half wave of current, and ends there: the next half wave can not pass any more without a new high-voltage discharge. Thus the multigap even at the highest discharges short circuits the system only for a part of one-half wave; that is, for such short time as not to interfere with the operation of synchronous machines, the parallel operation of generators, etc. It therefore has become the type of arrester almost universally used, especially in general distribution circuits, as the primary 2,200-volt alternating lines. For the latter, usually only two shunt resistances are used, a high one and a low one.

"The multigap affords very good protection against momentary lightning, as a single discharge or a few successive discharges. It however can not take care of continuous lightning, but when exposed to continuous lightning it is burned up. The reason for this is: the heat produced by the short circuit of the multigap during a part of a half wave, or even a few half waves in case of several successive discharges, is not so great that it could not be absorbed by the metal cylinders of the multigap and gradually dissipated. In continuous lightning, however, where hundreds or thousands of discharges follow each other per second, and every discharge produces a short circuit over the multigap for one-half wave, this amounts to a continuous short circuit over the arrester, and the heat produced by this very soon destroys it.

"To protect also against continuous lightning, as arcing grounds or other internal surges, as they are especially frequent in cable systems and high-voltage transmission lines, a lightning arrester is needed which passes the over voltage; that is, the lightning disturbance, but does not pass the main current at all. This requires an arrester of the counter-e.m.f. type, that is, an apparatus which opposes the line voltage by a counter-e.m.f. equal thereto, but permits a free path to any excess voltage. To illustrate: a 500-volt storage battery in a 500-volt direct-current circuit would accomplish this, if of negligible internal resistance; at normal voltage of 500, it would take only a very small current (the current required to keep it charged), but any voltage in excess of 500 would be short circuited. This is in general the principle on which the aluminium cell acts in direct-current as well as in alternating-current circuits; on the aluminium surfaces, which are submerged in the electrolyte, a film is formed which holds back the main voltage, but any excess voltage passes freely through it. An aluminium arrester therefore can discharge continuous lightning continuously, or at least for a sufficiently long time to find and eliminate its cause.

"The aluminium cell affords the most complete protection against all high-voltage disturbances, whether momentary or repeated. It has this disadvantage, however, that when left continuously in circuit it requires artificial cooling, and the life of the aluminium plates is still rather limited. It therefore is generally used in series with a small gap, set for a voltage a little above the line voltage. In the latter case, the aluminium arrester receives current only when the gap jumps across by an over voltage. This latter arrangement is very satisfactory, and seems to give a practically unlimited life of the aluminium plates. It has however the disadvantage that it requires systematic attention; the plates must be regularly charged, so as to retain the film which opposes the normal line voltage. When neglected for a considerable time, their protective film

gradually dissolves, and a discharge over the arrester then finds a short circuit instead of a counter-e.m.f. In other words, for more complete protection, something has to be paid in the systematic attention to the protective apparatus. The usual type of high-voltage alternating aluminium arrester comprises a series of aluminium cones inside of each other. The spaces between the cones are filled with the electrolyte, and the structure immersed in oil. The number of cones required depends upon the voltage of the circuit, as each aluminium cone can hold back about 250 volts."

SULPHURIC ACID FROM COPPER SMELTER FUMES.

A DESCRIPTION OF THE NEW SULPHURIC- ACID PLANT OF THE DUCKTOWN SULPHUR, COPPER AND IRON COMPANY.

W. H. Freeland and C. W. Renwick—Engineering and Mining Journal.

BRIEF reference was made in these columns in our issue for February, 1909, to the methods developed by the Tennessee Copper Company and the Ducktown Sulphur, Copper and Iron Company for the recovery of sulphuric acid from copper smelter fumes. The plant of the Tennessee Copper Company was placed in operation late in 1907; that of the Ducktown Sulphur, Copper and Iron Company has been opened only a little over a year. The latter installation covers a larger area than any other single undertaking of the kind in existence, and its design is an embodiment of the very latest practice in by-product copper smelting. A brief description is taken from an article by W. H. Freeland and C. W. Renwick in the *Engineering and Mining Journal* for May 28.

"The problem presented was a novel and complex one. It imposed many conditions foreign to the usual sulphuric-acid manufacturer, such as the contamination of the gases (smoke) by flue dust, unavoidable in blast furnaces; irregularities in furnace conditions and consequent fluctuations in temperature and in composition of the gases; the presence of carbon dioxide from combustion of coke (which, unfortunately, cannot be entirely dispensed with even in pyritic smelting as developed by the Company before the introduction of the acid process), and further increased by an appreciable quantity from calcium carbonate in the ore, which at furnace temperature yields lime and carbon dioxide.

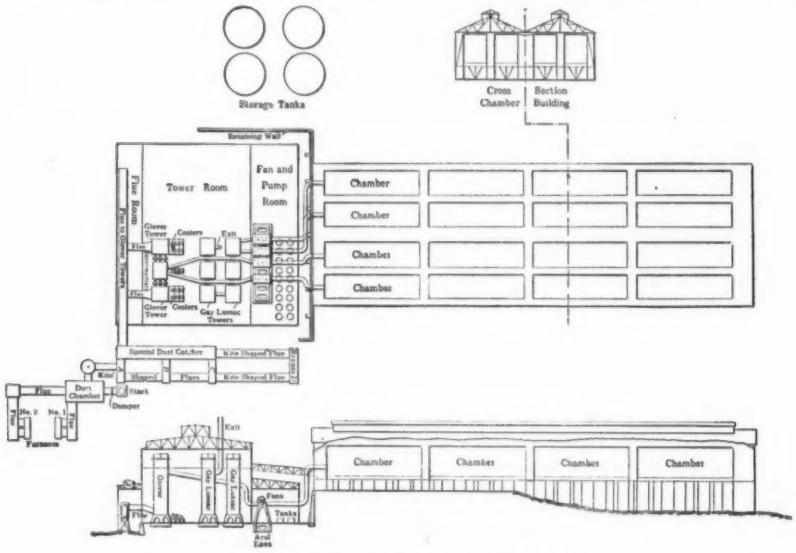
"Owing to the fluctuations in composition of the gas, an average analysis would convey little idea of conditions to be met and provided for. Under fairly normal conditions the gases delivered to the chambers are approximately as follows: SO_2, 3½ per cent.; CO_2, 3½ per cent.; and SO_3, trace. The temperature of the gases in the furnace flues frequently records a range of over 200 degrees C. in every eight or ten minutes.

"A chamber acid plant of ordinary design would be wholly inadequate to meet such variable conditions. The flue dust calls for special consideration since it carries a large percentage of zinc in the form of impalpable sulphates and oxides, that are prone to be carried into the system, clogging the gas passages and flues and even the circulating acid pipes. Moreover, zinc in itself is an important by-product to be recovered. It is in the special provisions, designed to meet these exceptional conditions, that this plant chiefly differs from the ordinary chamber plant.

"The course of the gases may be traced on the accompanying outline plan and elevation. The original smelting plant, before the manufacture of sulphuric acid was commenced, consisted of two furnaces of the usual water-jacketed type, each with an independent brick flue leading to a common brick dust chamber, at one end of which stands the old smoke stack, now cut off by a damper. From the furnace-dust chamber the gases now pass into and rise through a cylindrical tower, thence through a

kite-shaped flue to the special dust catcher on a somewhat higher level. This dust catcher, with its connecting and extension flues, claims particular attention, as these control and regulate the temperature of the gases delivered to the Glover towers, as well as eliminate the zinc and other light dusts. The dust catcher proper consists of a rectangular brick chamber containing a system of channel irons. Each channel is held in place by trunnions resting in the walls.

"The control and regulation of the temperature of the gases is accomplished by directing their flow through a greater or lesser distance of the kite-shaped iron flue leading into the dust catcher. Referring to the plan, A, B and C, the tower-like extensions of the dust catcher, afford entrances thereto, while a fourth point of entrance is seen at its posterior end. By a simple system of dampers the gases may be admitted at any or all these entrances, in any de-



PLAN AND ELEVATION OF THE ACID PLANT.

On one side the trunnions extend through the side wall, the ends being squared to take a wrench, by which means they can be revolved and their accumulated contents periodically dumped to the floor and later withdrawn through appropriate openings underneath. The coarser particles of flue dust readily come to rest in the anterior flues and furnace-dust chamber. The impalpable metallic oxides and sulphates respond but slowly to gravity at high temperatures, even at the slow speed attained in the flues and dust chamber, hence the introduction of the channel irons offering surfaces of repose at all points between the floor and roof of the dust catcher.

sired proportion. On high temperatures, caused by exceptional conditions of the furnace, the gases are cooled by passing them through the whole course of the kite-shaped flue. On lower temperatures the whole or part may be admitted at any earlier point or points.

"From the dust catcher a brick flue runs the full length of the tower building with separate off-takes to each Glover tower. In each of these off-takes are placed niter boxes for the decomposition of the sodium nitrate. There is also an auxiliary set of similar niter boxes at the end of the dust catcher for use in emergencies. In addition to these, a special and original method of dealing

with the valuable nitrous compounds has been worked out and put into successful operation.

"The gases having been cleansed of dust and brought to the proper degree of temperature are now ready for the first step of the process, viz., the two Glover towers, each 12 feet square and 45 feet high, filled with checkered layers of a patent chemical brick. Entering at the bottom of these towers, the gases ascend to the top, whence they are led downward again through a system of external pipes to enter the bottom of a special tower through which they again ascend and pass on their way to the chambers through two lead flues, each 42 inches in diameter. Special mention should be made of the extremely high oxidation of the SO_2. In these towers fully 40 per cent. of this gas is converted into SO_3. The concentration of the chamber acid is accomplished without any external aid from cast-iron pans, etc., generally used in the ordinary chamber process. While this plant has a normal rated capacity of 160 tons 60 degrees B. acid per day, it has been demonstrated that this quantity does not represent the maximum tonnage that can be produced, and furthermore a concentrating capacity of over 200 tons 60 degrees B. acid per day has been attained when needed.

"Situated between the towers and the chambers are four powerful fans to force the gases through the system. These consist of similar units, two forcing the gases into the front chambers, and two withdrawing them from the rear. These fans are made of hard lead (10 per cent. antimony and 90 per cent. lead) and are of special design. Next in train are the sixteen chambers, comprising two sets of eight each. Each chamber is 96 feet long, 22 feet 8 inches wide, and 30 feet high. The total volume of the chambers is 1,050,000 cubic feet. It is at this point in the process that the contaminating influence of the carbon dioxide is felt, and where special and novel features, of a proprietary nature, are successfully introduced to overcome its pernicious effects.

"From the chambers the gases pass into the six Gay Lussac towers, where the nitrogen compounds are recovered in the same manner as in all modern and well regulated chamber plants. It has been the belief of many acid manufacturers that only a 'sludge' acid could be produced in a chamber acid plant, utilizing the waste sulphur gases from a pyrite smelting furnace." This plant demonstrates the fallacy of the belief, the acid delivered from the towers to the storage tanks being pure and clear.

"Smelting operations have been reduced to a one-furnace basis to meet the capacity of the acid plant. This furnace smelts pyrrhotite ore six days in each week, the seventh day being devoted to the concentration of the low-grade matte produced during the ore-smelting period. The ore treated varies almost daily from 14 to 19 per cent. S, and averages about 16 per cent. S; the low-grade matte averages about 25 per cent. S. The problem of utilizing the gases from the matte concentration proved a simple one and considerably more acid is produced on this one day than on any of the ore-smelting days."

SCIENCE AND INDUSTRY.

A DISCUSSION OF THE PLACE OF SCIENTIFIC RESEARCH IN MODERN INDUSTRY.

Leo H. Baekeland—American Electrochemical Society.

IN the concluding article of his series on the compensation of workmen and efficiency of operation, presented in THE ENGINEERING MAGAZINE for June, Mr. H. L. Gantt emphasized the fact that while superb natural resources have enabled the United States to make phenomenal progress without much regard to the teachings of science and in many cases in spite of neglect of them, a point has now been reached where it must be recognized that the proper application of science to industry is of vital importance to the future prosperity of the

country. At greater length Dr. Leo H. Baekeland discussed the same subject in his recent presidential address before the American Electrochemical Society, from which we abstract a few paragraphs dealing particularly with the place of scientific research in modern industry, after a report of his address in *Metallurgical and Chemical Engineering* for June.

"If this be the age of rational industrialism, of applied science, how is it that in some industries quality is going down while prices are soaring upward? It is a noteworthy fact that just such commodities as are produced by so-called scientific industries are sold cheaper and are of better quality than ever before, and this cheapening in price or bettering in quality is almost proportionate to the amount of scientific knowledge involved in their production. Let us take, for instance, the chemical and the electrical industries, both based nearly exclusively on well developed scientific data. In both these groups of industries the chemist or the physicist has had full sway and the engineer has embodied their work in a practical form. Free and rational competition based on intellectual superiority has been their paramount factor of development. Competition based on artificial privileges, like labor unions, tariff legislation, have paid only a secondary rôle.

"In some cases the changes are remarkable. For instance, a ton of sulphuric acid sells now at the same price as two pounds of the same article were sold about 150 years ago. Compare this with industries which are still under the sway of the rule of thumb, which means the rule of the ignorant, or where competition is based on political protection; you will find that just such rule-of-thumb commodities where science plays no role are those for which the public has to pay the highest price for the poorest article.

"Notwithstanding all our progress, it is evident that we live in a transitory stage; next to enterprises and industries embodying the highest intellectual conceptions our century can offer, we find even in the most advanced countries examples of conditions of affairs which seem truly an anachronism. To many of you it has happened to visit factories or mills where ignorance and greed seemed the two dominant factors, where the class of men and women employed, not to speak of child labor, seemed to have undergone the full curse of their sordid surroundings. Such places are to be found often where the mental condition of the directors does not enable them to go beyond the conception of size, and where the whole tendency has been toward more, more, more, instead of toward better, better, better. How different is this from some of our better engineering and chemical enterprises where everything bears the imprint of a steady effort toward progress and where employer and employed alike seem to undergo the uplifting force of intellectual aims. Such a happy condition of affairs is most likely to be encountered where the head is himself the scientific pioneer who has built up the enterprise.

"Matters are not always so satisfactory where large organizations have gotten into the hands of a board of directors who know little else of the technical side of the business than that it pays dividends, and for whom the main interesting factor is the value of the shares they own. Whenever undertakings are ruled by such a class of men, we must not be astonished if their corporation counsel is more in evidence than their chemists or their engineers. What do they care if certain improvements in their processes might net them 5 per cent. more or mean better goods, if on the other hand they know that by a clever trick of law they can extract from the consuming public many times more? No wonder, then, if they have less time and less mental fitness for a principle of science or engineering involved in a new process than for a conference with eminent law counsel. If they cannot alter nature's atomic weights, they may find a way of improving their invoice weights for the custom house. Again, we find that, resourceful as the modern engineer or

chemist is, his power is often simply a tool in the hands of ignorant but cunning men. In fact, our modern laws and society insure better reward for cunningness or slyness than for true intellectuality.

"Quite frequently the real field of usefulness of scientifically trained men is much misunderstood. For instance, it is a common mistake, made even by some engineers and physicists, as well as by business men, to imagine that the main work of the chemist is confined to performing chemical analyses. This conception is about as absurd as to think that the usefulness of an electrical engineer consists in making electrical tests or that the essential work of the merchant is bookkeeping.

"Some of the better educated people in this country begin to understand more and more the necessity of scientific research. Not so long ago, research work was only carried out in the laboratories of universities or in a few highly developed chemical or electrical companies; nowadays we find many intelligently conducted enterprises devoting a considerable annual outlay for systematic research work, where the resources of the chemist, the physicist, and the biologist are used to good purpose. Unfortunately, the scope and method of scientific research is difficult to understand for the uninitiated. Some people have only the haziest conceptions on this subject. Some manufacturers, totally unaware of the requirements involved in this work, in a half skeptical way, grudgingly conclude to organize a research department, sometimes as a last resort, to help them through some difficulties; others do it 'to be in style,' and simply to imitate their more successful competitors. Frequently they engage a young man with little experience, who, outside of what he studied in the technical school or at the university, has everything to learn, and who besides that, is usually entrusted at the very start with the most difficult problems. His salary is none too high and his action is very much restricted; sometimes he is forbidden to study the current practical methods, or so-called 'manufacturing secrets,' and is thus prevented from getting acquainted with the very problems he is supposed to solve. I have seen other cases where the time of the research chemist was filled with odd jobs of every kind. After a while, when practical results are not forthcoming fast enough, the bookkeeper confronts him with the list of expenses which have been incurred by his work; naturally some comments are ready at hand how the same money spent on a good salesman would have shown immediate results, and so forth. Things go along that way for a while until the research department is abolished with the recurring remark: 'Research does not pay; we've tried it.'

"In other cases, where some results are obtained, the matter is taken out of the hands of the chemist before he has had time to fairly try and develop it on a large scale. The subject is now entrusted to the superintendent or the foreman, who seldom is a friend of the scientifically trained man, and nearly always resents anything which might diminish the prestige of established practical experience. Like in all new processes, defects are soon shown, and in the natural order of things repeated failures and renewed trials on a practical scale are required before there is any possibility of regular utilization. The research chemist is allowed very little intervention at this stage of the work, and after some time, remarks are heard how imperfect the whole thing was 'before so-and-so, the practical man, had his say.' Finally, initial expenses are charged against the research department, while the profits are credited to the practical man.

"A research department is a very difficult thing to organize and to run. It is not enough to provide a building and the necessary appliances; it is not enough to provide typewriters, card-indexing systems, and office force, and all the red tape connected with it; it is not sufficient to engage one or more well-behaved university or college graduates with the necessary helpers and to let them work

under an orderly, businesslike manager. The most important, the almost exclusive factor in a successful research laboratory is the research chemist himself. If he is not a man who has a soul alive with his subject, if he is not enthusiastically imbued with his opportunities, if he is not qualified for his task, not only by scientific training, but specially by a natural gift of discrimination between what is most important in a problem and what is secondary to it, you might as well fill a hall with the marble statues of Greek poets and imagine that they will write poetry for you. Even if you have the best qualified research chemists, do not expect immediate results. Do not forget that problems, appearing most simple, require considerable time before they are thoroughly studied. Even in successful cases, it may easily require many years before a subject is so thoroughly elucidated that it can be taken up in practice.

"Let me give also a warning to such manufacturers as try to secure only by uncompromising secrecy the money-making end of their industries. As far as my experience goes, exaggerated secrecy is very often an indication of lack of knowledge of industrial feebleness and incompetency; a miser is most of the time a man of small means. If the chemists had been holding their results from each other, we would still be in the dark ages of the alchemist. No secrecy, however jealously carried out, can outweigh enlightened research work, protected by wise patent legislation. If our patent laws do not protect enough, then our prime duty becomes to change them until they answer their purpose as defined by the Constitution of the United States. The care with which patent laws are administered is a direct measure of the industrial importance of a country. Piracy cannot flourish, neither on the seas nor in intellectual property, if ethics of justice and equity can be made to prevail. Every recorded success of the scientist or the engineer is an additional evidence that ignorant greed and brutal rapacity cannot forever have full sway in this world, and that the rule of the sly and the shy leads to the abortion of progress."

ELECTRIC SPOT WELDING.

A BRIEF REVIEW OF THE METHODS, APPARATUS AND APPLICATIONS OF THE SPOT WELDING PROCESS.

A. E. Buckenberg—Electrical World.

SPOT welding, the latest development in electric-welding processes, which is coming into extensive use for a great variety of work, has only one feature in common with ordinary butt welding, the formation of molecular union between semi-fluid metals by means of mechanical pressure. In general, electric butt welding is applicable to joining the ends of bars, rods, forgings, etc. The heating current is approximately evenly distributed over the entire area of the abutting surfaces; when a welding temperature is reached the two pieces are forced together endwise. Spot welding, on the other hand, is limited to the welding of overlapped sheets with comparatively large areas of metal in contact. Only a small percentage of the actual contact area is joined, the welding area being confined to one or more distinct "spots." The heating current does not flow across the entire area of the contact surface, but is localized at the spots, while the remainder of the stock remains cold.

In *Electrical World* for June 2, A. E. Buchenberg outlines the means by which concentration of the heating current may be accomplished. Two methods are employed. "The first, commonly known as 'point welding,' necessitates the raising of slight independent points or projections on either one or both of the surfaces to be spot welded. These points prevent the entire overlapped surfaces of the stock from coming together, and the contact between them is, of course,

made on the projecting points. If current is now caused to flow across the two pieces of work by means of flat current-carrying dies or electrodes (one on each side), the current between them must obviously be concentrated at the contracting points or projections of the metal. These projections under the heating action of the current almost instantly reach a fusing temperature, and the weld is completed by mechanical pressure exerted upon the dies to force the flat surfaces of the stock together. The points or projections on the metal may be of any size or shape to obtain the proper conditions of assembling or mechanical strength for any particular piece of work. One or more spots may be welded at the same instant with one operation. The principal objection to this method is the necessity of preparing the stock under a punch or press for the welding operation, and the difficulty of assembling some classes of work with projections on the surface of the stock.

"With the second method no preparation of the stock is required. The heating current is concentrated to the area of the spot to be welded by means of pointed dies or electrodes, one on each side of the work, whose opposed ends are shaped to the size of the spot weld required for any particular piece of work. The weld is completed as in the first method by means of mechanical pressure to force the dies together."

The essential parts of a spot-welding equipment for either of these methods are four: (1) a transformer to reduce the line voltage to the very low voltage required for welding; the current used is single-phase alternating; (2) two welding dies, one attached to either terminal of the transformer secondary winding, consisting of flat copper plates for the first method and short copper rods with rounded ends for the second method; the die-supporting mechanism is arranged to allow a limited motion of the dies toward and away from each other; (3) a powerful cam or toggle compression machine operating through the die supports, to exert mechanical pressure on the material between the dies; and (4) a switch to open and close the circuit through the primary coils of the transformer.

"The operation of the machine is as follows: The two parts to be spot welded are properly located by means of a jig between the opposed ends of the welding dies, which are normally separated to afford the proper clearance. The dies are now brought together by means of the compression handle to grip the stock between them. At this stage only enough pressure is exerted to bring the welding surfaces into contact. The switch is now closed and the stock begins to heat at the one spot directly between the opposed faces of the dies. When a welding temperature has been reached, the switch is opened and heavy pressure exerted by the compression lever to form the weld. The time required to make a spot weld is short, ranging from a fraction of one second on thin stock to three or four seconds on 0.25-inch stock. The time during which the current is used is so short that only a very small amount of heat is carried to the surrounding metal by conduction. On the thinner stock the discoloration from heat is barely noticeable beyond the area covered by the welding dies, while with heavier stock the discoloration may extend to a distance of 0.125 inch all around the weld.

"The diameter of the spot welds will depend upon the size of the projections thrown up on the surface of the metal or upon the area of the welding die contact points, which in either case may be of any desired area. Since the ultimate strength of the weld will in most cases be determined by the tearing strength of the metal around the circumference of the 'spot,' the diameter need not be great. A diameter of 0.25 inch is amply large for No. 20 gage stock and 0.375 inch for 0.25-inch stock. The number of welds required for any particular piece of work will depend upon manufacturing conditions and strength requirements." The momentary current required to make a spot weld is considerable, but the time is very short. Expert labor is not required. The actual energy

consumption of the machine is surprisingly small and the cost of operation low.

When the stock has been previously prepared by punching up projections, as in the first method mentioned, flat welding dies of considerable area may be used. The heated plastic metal of the projection is brought back practically flush with the surfaces of the sheets under the pressure, and a smooth surface is left. In the case of comparatively heavy metal the depression left by the punch will be more prominent. The heat discoloration, as noted above, will, of course, always be present.

"Spot welds made without preparation of the stock by the use of pointed or rounded dies will usually show a slight depression below the surface of the plate on both sides of the work. These depressions will conform to the shape of the ends of the dies and are caused by the pressure exerted while the stock is hot. They are always slight, being hardly noticeable on thin stock and reaching a maximum depth of 0.03 inch on 0.25-inch stock. The usual heat discoloration is present in this method, as with the first. If it is desired to obtain a perfectly smooth, unbroken surface on one side of the stock and avoid the inconvenience and expense of preparing the stock as in the first method, the pointed dies on this side of the work may be replaced by a flat die or plate of copper.

"It is not necessary that the thickness of the two pieces to be spot welded be the same. Dissimilar metals, such as iron and brass, can be spot welded to each other in a very satisfactory manner. Spot welding, on account of its low cost and superiority over riveting in strength and the elimination of projecting rivet heads, is being applied to a wide variety of work, among which may be mentioned metal utensils, hardware specialties, metal furniture, automobile bodies, metal door and window casings, etc."

THE APPLICATION OF THE STEAM TURBINE TO LOCOMOTIVES.

A BRIEF ACCOUNT OF THE REQUIREMENTS, A SPECIAL LOCOMOTIVE TURBINE, AND THE RESULTS OF SERVICE TESTS.

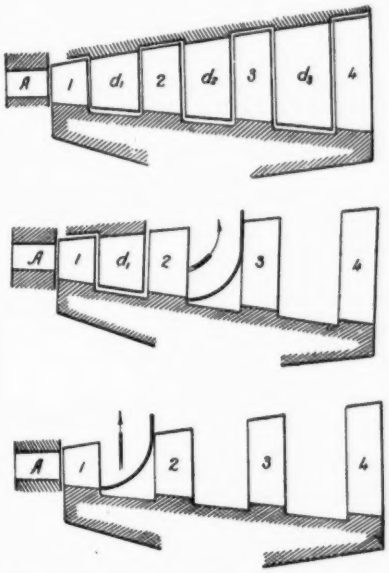
G. Belluzzo—Collegio degli Ingegneri ed Architetti in Milano.

THE possibility of applying the steam turbine to locomotives is under investigation on a considerable scale by a firm of engineers in Milan, Italy. A turbine of special design has been applied to an old locomotive and extended service trials have been carried out under exacting conditions. A few data of the results were made public in a paper read by G. Belluzzo in March before the Milan Association of Engineers and Architects, which is abstracted below, after reports in *L'Industria* for April 10, and *Revue Industrielle* for April 23.

Sig. Belluzzo first discussed the application of the steam turbine to marine service. A definitive and wholly satisfactory type of marine turbine, he says, has not yet been developed. The principal requirements are two, reversibility and a fair economy at variable speed, the latter particularly in war vessels. Reversing is accomplished by means of a special turbine, mounted on the same shaft as the main ahead turbine, but operating in the opposite direction, which turns in the condenser vacuum while the ship is going ahead. Its power is never more than one-half that of the main turbine. The problem of securing a reasonable economy at variable speed has not yet been satisfactorily solved; steam consumption per horse-power hour at mean speed is about 1.75 times that at full speed. It is important to remember that in marine applications of the turbine, there is an intimate relation between the speed and the power developed by the propulsive machinery; the power required at half speed is only one-eighth of that necessary at full speed.

On account of the nature of the service required of locomotives and the variations in the profile of the line, it is impossible to lay down any fixed rule

connecting the power required and the speed. A locomotive may be called upon to develop its maximum power at various speeds, or various powers at a certain fixed speed. Further, the power must be the same whether the locomotive is running backward or forward and the machine must start under load. On the other hand, the space available for the driving machinery is very limited. A high efficiency is required under certain special conditions, as, for example, at full power and full and one-half speeds, inasmuch as the variation of steam consumption with power and speed in actual practice is of the order of 40 per cent.



FIGS. 1, 2, AND 3. SECTION OF TURBINE.

With the steam turbine, variable speed and high efficiency can be obtained by means of the arrangement illustrated in Figures 1 to 3. In the diagrams, *A* is a distributor in which the steam is expanded from the pressure at which it reaches the turbine to the pressure within the turbine casing. *1*, *2*, *3*, and *4* are sets of moving blades. At low speed the steam operates on all the blades in series (Figure 1), being directed by intermediate guides, d_1, d_2, d_3. At high speed it operates only on the first set (Figure 3), and at intermediate speeds, on two or three sets (Figure 2). The variations in efficiency and steam consumption are those which would obtain with a reciprocating engine at variable speed and load.

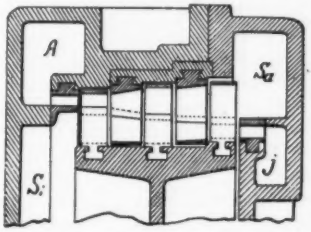


FIG. 4. REVERSING DEVICE.

Reversing is accomplished by means of the arrangement illustrated in Figure 4. The rotors carry two sets of blades, which are of opposite curvature. For operation in one direction, the steam is admitted at *A* and escapes at S_a; for reverse operation, admission is at *j* and escape at S_j. In either case the loss of energy due to the fan-like action of the second set of blades is a very small fraction of the total; numerous experiments made under various conditions of pressure and density of the steam have shown that the loss is only from 2 to 3 per cent. Starting under load is possible only with a turbine of the present type, by allowing the steam to operate on all the sets of blades at once. By this means the maximum turning moment is obtained with the least expenditure of steam.

A turbine of this type has been given a practical test by Miani Silvestri, Comi and Grondona, a firm of engineers in Milan. The turbine was applied to an old locomotive built in 1876, which was entirely reconstructed for the purpose. The boiler had about 650 square feet of heating surface and produced steam at about 142 pounds per square inch. The locomotive had originally three driving axles, but in the reconstructed machine the total weight, about 26 tons, is carried on two axles, between which the power of the motor, about 100 horse power, is divided.

The tests have been made on a very rough stretch of track. Accurate records of the variation of steam consumption with load and speed have been obtained. The steam consumption has never exceeded 35 pounds per horsepower hour in running in either direction. It is certain that a locomotive of double the weight and 6 to 10 times the power would give considerably lower results, with a boiler pressure 50 per cent. higher. The locomotive has started well under load, both on straight track and on curves, the turning moment being somewhat less than 3,500 foot-pounds.

The experiments have demonstrated that the advantages to be obtained by the application of the steam turbine to locomotives are the following: (1) possibility of higher speed; (2) suppression of oscillations; (3) a saving in lubricants; (4) a distinctly higher fuel economy; (5) longer life and lower maintenance costs; (6) greater ease of operation; and (7) elimination of danger in reversing.

SPECIAL AND STOCK HYDRAULIC TURBINES.

A COMPARISON OF THE CHARACTERISTIC FEATURES OF BUILT-TO-ORDER AND STOCK REACTION TURBINES.

H. Birchard Taylor—Engineering News.

IN his review of the development of the hydraulic reaction turbine in America, contributed to THE ENGINEERING MAGAZINE for March last, H. Birchard Taylor called attention to a fundamental difference between American and European practice in the early years of reaction-turbine design. In America reliance was placed almost wholly on empirical data, and hydraulic turbines were designed largely by the "cut-and-try" method. In Europe, on the other hand, the development of the reaction turbine was the outcome of mathematical investigation and its evolution was based largely on theory. This difference in method of design led to a difference in method of production. The typical American turbine was made from stock patterns in stock sizes; European turbines were almost universally built to order and it was customary to design each machine for the actual conditions of power, head and speed governing its installation. Within recent years, however, American designers have adopted European methods with, as Mr. Taylor shows very clearly, remarkably successful results, while the stock turbine has been introduced to some extent in Europe. Practice on both sides of the Atlantic now approximates to uniformity in methods of turbine production.

Progress in the production of theoretically correct built-to-order turbines has by no means displaced the stock turbine from the American market. There is a growing demand for the stock turbine and the manufacture of this grade of machinery has developed into a large and profitable industry. Mr. Taylor has indicated, in an article contributed to *Engineering News* for May 26, the characteristic features of special and stock hydraulic turbines and the fields to which they are respectively adapted. It is rare, he says, to find both classes of apparatus manufactured by the same concern. The grade of workmanship is much higher in the special turbine, and the makers of hydraulic machinery find it impracticable to turn out two grades of workmanship in the same shop. Hence the manufacture of special and stock turbines embraces two specialized industries.

The built-to-order turbine, as a rule, has a far higher efficiency, both hydraulic and mechanical, than a stock turbine which would apply to the same conditions. Stock turbines are made in lots from standard patterns. They are distinctly a product of the testing flume, and while very high efficiencies have been recorded in flume tests of stock runners, such results cannot be depended upon as a reliable indication of the economy of the completed unit. In general,

stock runners are applied to inefficient wheel casings and draft tubes, and, consequently, the efficiency of stock turbines as a class is low. Under the conditions for which they are intended, however, stock turbines have given entire satisfaction. They find their application in cases where low first cost and quick delivery are the principal requisites, and where efficiency, cost of maintenance, regularity of operation and appearance are secondary considerations. The fact that first cost is the controlling factor in the purchase of equipment in the majority of small installations will insure a steady increase in the demand for the stock turbine.

The difference in cost between special and stock turbines is easily explained. The drawings and patterns for a made-to-order turbine are seldom, if ever, used a second time, except for duplicate machines for the same power house. Two installations rarely require wheels for exactly the same combination of the variables on which the design of a turbine depends. The development charges constitute a large part of the cost of hydraulic machinery, and in the case of the made-to-order turbine these must be charged to the cost of the unit. The manufacturer of stock turbines, on the other hand, can in most cases supply a standard machine which can be adapted to fulfill the conditions. Even if he has to make a new set of patterns, their cost is not charged to the individual unit but to plant, since the patterns can be used for the construction of many turbines for installations offering approximately the same conditions.

"The principal field of application for the stock turbine is for heads under 100 feet and for capacities not exceeding 2,000 horse power. Owing to the absence of development charges and the resulting low first cost of this class of apparatus, the stock turbine has a great advantage within this range, and the market for made-to-order turbines, within these limits of head and power, is confined to cases where the question of efficiency is of prime importance, or where unusually high factors of safety are required in the construction, owing to peculiar local conditions.

"The made-to-order turbine finds its application in installations where one or more of the following requirements are of principal importance: (1) high efficiency; (2) non-erosion of the runner vanes, a requirement which becomes more important the higher the head; (3) high factors of safety in the construction of the apparatus; (4) low operating expense; (5) unusual design called for by peculiar local conditions; (6) capacity considerably above the range to which the stock turbine may be applied; (7) heads much over 100 feet. In all of these cases the question of first cost must necessarily be of secondary importance.

"In installations where special turbines are required and where efficiency is the most importance of all considerations, it has been customary in recent years for the purchaser to require the manufacturer to guarantee the efficiency of the apparatus on a bonus-and-penalty basis, the rate depending on the value to the purchaser of that increase in the power output which is obtained by a gain of 1 per cent. in the efficiency. A common rate has been $1,000 for each per cent. per turbine. If the contractor exceeds his guarantee by 1 per cent. it does not necessarily follow that he has made $1,000. Especially is this true when the value guaranteed is about the highest efficiency which would be expected for the conditions of power, head and speed, and the contractor in an effort to exceed his guarantee goes to considerable expense in the construction and testing of experimental runners" and in the construction of the turbine of more liberal proportions than he counted on when he signed the contract. The extra expense is justified, however, provided the experiments and the enlargement of the turbine do not increase the cost by more than the amount of the bonus.

Stock turbines as a class have experienced much trouble from erosion of the wheel vanes, especially when they have been applied to the higher heads. "Erosion depends primarily upon the design. To eliminate it, among other things, the

hydraulic design must be very close to the correct, and the allowable variation from the correct is less the higher the head. As has been pointed out, in a majority of the applications of the stock turbine the conditions of power, head and speed are somewhat different from those for which the wheel was originally intended; consequently the design cannot be said to be very near the correct. The natural result, in a great number of cases, is the rapid erosion of the wheel vanes, a condition which not only reduces the efficiency of the turbines at an accelerated rate, but soon destroys the vanes to such an extent that the runner or runners must be replaced. Thus the maintenance of the turbine becomes an important item.

"Turbines which are fed by long penstocks are more or less subject to fluctuations of pressure in the wheel casing. In such cases it is extremely important to have the turbines designed especially to withstand the resulting variation in the stresses in the wheel casing and head plates. The magnitude of the pressure change depends, among other things, upon the length of the penstock and upon the rate of the change of the velocity of the water in the penstock. The rate of change of velocity depends upon the velocity of the wheel gates as they are moved by the governor to suit the variations in the load."

When the gates of a turbine close to suit a drop in the load, the force required to decrease the velocity of the water flowing in the penstock is evidenced by a rise in the pressure in the wheel casing. Conversely, when the gates are opened to suit an increase in load, the force required to increase the velocity of the water is evidenced by a fall in the pressure in the wheel casing. The question of the pressure variations to which a turbine may be subjected deserves the most thorough study before the various parts are proportioned and the thickness of metal chosen.

"The elementary action involved in these pressure fluctuations is not very complex. But in actual practice there are many influences which modify the phenomenon to a greater or less degree, and consequently it is practically impossible to derive a formula which would take into consideration all the phases of the subject. Approximate results, however, may be calculated which should be of value to the designer." Assuming that the penstock is frictionless and inelastic, that the discharge is proportional to the gate opening, and that we are dealing with an incompressible fluid, results close enough for all practical purposes are obtained from the formula.

$$p = 0.0134\, L\, \frac{v_1 - v_2}{t}$$

in which p is the pressure change in pounds per square inch, L, the length of the penstock in feet, v_1 and v_2, the initial and final velocities of the water, and t, the time in seconds required to change the velocity from v_1 to v_2 or from v_2 to v_1.

"The rise or fall in the pressure is directly proportional to the length of the penstock, directly proportional to the difference in velocities corresponding to the two loads on the turbine, and inversely proportional to the time required to move the wheel gates. It is easily seen that, for loads coming on the turbine, if the time for the movement of the gates is not adjusted to the inclinations of and the velocities through the various sections of the penstock, the fall in pressure may be such as to reduce the pressure in a section of the penstock below the atmospheric pressure and cause its collapse.

"In actual practice the pressure fluctuations are considerably reduced by means of surge tanks, standpipes and relief valves. Still, in cases where very long penstocks are required and where rapid movements of the wheel gates are necessary to secure good regulation, the designers should appreciate the importance of going into this question thoroughly and of making liberal allowances in choosing the factors of safety in the construction of the turbine."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING	Page 607	MECHANICAL ENGINEERING	Page 624
ELECTRICAL ENGINEERING	" 615	MINING AND METALLURGY	" 636
INDUSTRIAL ECONOMY	" 621	RAILWAY ENGINEERING	" 643
MARINE AND NAVAL ENGINEERING	" 622	STREET AND ELECTRIC RAILWAYS	" 646

CIVIL ENGINEERING.

BRIDGES.

Arches.

Determination of Wind Stresses in Three-Hinged Arches. J. Ensink. Gives methods and diagrams recently worked out by the author in connection with an arch span carrying a water main. 2500 w. Eng Rec—May 21, 1910. No. 14148.

The Analytic Calculation of a Concrete Arch. Malverd A. Howe. Detailed discussion of the necessary steps in designing an arch rib or ring of reinforced concrete, according to the elastic theory and the unit load method. 3000 w. Eng News—May 12, 1910. No. 13891.

Floors.

See Waterproofing, under CONSTRUCTION.

Frankfort, Germany.

Frankfort's Bridges. Illustrates and describes interesting structures. 1200 w. Pub Works—Jan., 1910. No. 14175 A.

We supply copies of these articles. See page 647.

Piers.

The Copper River Bridge Piers. Illustrated description of piers constructed where the substructure must resist pressure and impact from large flows of thick ice and from very heavy icebergs formed by glaciers. 600 w. Eng Rec—May 14, 1910. No. 13906.

Quebec.

An 1800-Ft. Steel Arch as a Quebec Bridge Project. Drawings and general description of a design for a voussoir arch to cross the St. Lawrence River at the site of the collapsed Quebec Bridge. 1200 w. Eng News—May 19, 1910. No. 14121.

Reconstruction.

Boylston Street Bridge Renewal Erection. Illustrated detailed description of a bridge across railway tracks in Boston. 2500 w. Eng Rec—May 7, 1910. No. 13798.

Reinforced Concrete.

Waterford Bridge. Illustrates the old and also the proposed bridge at this terminus in Ireland, explaining conditions, and the contest over the material to be used. 1200 w. Engr, Lond—April, 1910. No. 13737 A.

Reinforced-Concrete Highway Bridges (Strassenbrücken in Eisenbeton). Emil Morgenstern. Describes three recent structures in Germany. Ills. 2000 w. Beton u Eisen—April 5, 1910. No. 14213 F.

See also Arches, under BRIDGES.

Steel.

Decay and Protection of Railway Bridges. Illustrated notes on recent Scottish practice. Concrete is used for protection of the steel. 1000 w. Engr, Lond—May 6, 1910. No. 13982 A.

Stresses and Strains in Girder Work. Henry Adams. An illustrated study. 3300 w. Pub Works—Jan., 1910. No. 14176 A.

The Bailey Avenue Bridge, Buffalo. Illustrated detailed description of a bridge across railway tracks, of the through truss type. 2000 w. Eng Rec—May 7, 1910. No. 13800.

A 109-Ft. Concrete-Floor Plate-Girder Bridge. Illustrated detailed description of a bridge in Jersey City, N. J., carrying the D., L. & W. Ry. tracks across Tonnelle Ave. 800 w. Eng Rec—May 21, 1910. No. 14149.

The Superstructure of the McKinley Bridge at St. Louis. H. M. Morse and Ralph Modjeski. Illustrated detailed description of an important bridge across the Mississippi River. 2 plates. 2500 w. Eng Rec—April 30, 1910. No. 13623.

Suspension.

The Gisclard Type of Fixed Suspension Bridge (Les Ponts suspendus Fixes, Système Gisclard). G. Leinekugel Le Cocq. Discusses particularly the Cassagne bridge in the Pyrenees. Ills. 5000 w. Génie Civil—April 9, 1910. No. 14027 D.

Timber.

A Timber Bridge Supported on Cables (Pont en Bois sur Cables). Describes a unique bridge over the Tü Miniak in the Dutch East Indies. Ills. 1500 w. Génie Civil—April 23, 1910. No. 14030 D.

Trestles.

The Railway Bridge Across Albemarle Sound. Illustrated detailed description of a pile trestle having two large movable spans, and five fixed spans that permit the passage of motor boats. 2000 w. Eng Rec—April 30, 1910. No. 13630.

Viaducts.

The Bear River Viaduct. Illustrated description of a structural steel single-track viaduct 810 ft. long, and 192 ft. high above the river bed. 2200 w. Eng Rec—April 30, 1910. No. 13626.

A Three-Hinged Reinforced Concrete Arch Viaduct. Illustrated description of one of a number of similar structures built in the Union Stock Yards, Chicago, to meet peculiar conditions. 2500 w. Eng Rec—April 30, 1910. No. 13624.

CONSTRUCTION.

Beams.

Continuous Beams Over Three or Four Elastic Supports (Einflusslinien kontinuierlicher, auf drei oder vier elastischen Stützen gelagerter Träger). Karl Arnstein. Mathematical discussion of stress distribution. Ills. 6500 w. Oest Wochenschr f d Oeffent Baudienst—April 23, 1910. No. 14211 D.

Boring.

A Gasoline Motor-Driven Earth-Boring Machine. Walter Langford. Illustrates and describes the construction and operation. 1000 w. Sci Am—May 7, 1910. No. 13782.

Columns.

Experiments on Built-Up Columns. Herbert F. Moore. A study of the behavior of the parts of such columns under load. Ills. 2000 w. Technograph, No. 24—1909-10. No. 14374 N.

Concrete.

Subaqueous Concrete Work. H. R. Lordly. Describes operations of this character in connection with the Quebec canal system, particularly the construction of five miles of concrete wall without unwatering on the Lachine Canal. Ills. 7000 w. Can Soc of Civ Engrs—March 17, 1910. No. 14299 N.

Mixing and Handling Concrete in the Construction of Locks on the Panama Canal (La Fabrication et la Manutention du Béton dans la Construction des Ecluses du Canal de Panama). Ch. Dantin. Describes work at Pedro Miguel, Miraflores and Gatun. Ills. 3500 w. Génie Civil—April 2, 1910. No. 14025 D.

Domes.

Peculiar Spiral Arch of the Eskimo Snow House. A. L. Kroeber. Illustrated

We supply copies of these articles. See page 647.

description of the construction. 1000 w. Sci Am—May 7, 1910. No. 13781.

Earth Pressures.

Pressure Resistance and Stability of Earth. J. C. Meem. Detailed discussion of earth pressures, considering the resistance and stability as applied to piling and foundations, and the pressure on and buoyancy of subaqueous structures in soft ground. Ills. 12500 w. Pro Am Soc of Civ Engrs—April, 1910. No. 14340 E.

The Determination of Earth Pressures (Neue Versuche zur Bestimmung des Erddrucks). Prof. Ramisch. An exhaustive mathematical discussion. Ills. 5500 w. Zeitschr d Oest Ing u Arch Ver—April 15, 1910. No. 14204 D.

See also Retaining Walls, under CONSTRUCTION.

Excavation.

A Four-Wheeled Scraper of Large Capacity for Excavation and Grading. Illustrated description of a machine with a scraper of 1 cu. yd. capacity. 1000 w. Eng News—May 19, 1910. No. 14126.

Fireproof.

Fires: Effects on Building Material and Permanent Elimination. Frank B. Gilbreth. Urges the elimination of wood from all building construction. Ills. 4000 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14331 F.

Floors.

Cost of the Concrete Balcony Floors of the Lockport Power House, Chicago Drainage Canal. L. K. Sherman. Describes the construction of these reinforced-concrete floors, giving estimate of cost. The work was done by day labor. Ills. 1600 w. Engng-Con—May 25, 1910. No. 14394.

Concrete Floors with Crossed Reinforcement (Kreuzweise bewehrte Eisenbetondecken). H. Henningsen. Mathematical discussion of their design. Ills. 2000 w. Beton u Eisen—April 5, 1910. No. 14214 F.

Foundations.

A Method of Sinking Curbed Foundation Wells Using Shields and Compressed Air with Some Notes on Chicago "Caisson" Foundations. From a paper by W. C. Armstrong in the *Iowa Engr.* Explains conditions at Chicago and the methods used to give safe foundations for heavy structures. 3500 w. Engng-Con—May 11, 1910. No. 13913.

The Bryant Building Substructure. Describes methods of removing the old 9-story building on the site, and the interesting details of the caisson foundations, etc. Ills. 3000 w. Eng Rec—May 21, 1910. No. 14151.

The London County Hall. Information and drawings concerning the site and foundations, with description. 1800 w. Engr, Lond—April 29, 1910. No. 13860 A.

Gas Holders.

The Reconstruction of the Concrete Tank in Connection with the 150,000 Cubic Foot Gasholder, the Property of "The Light, Heat, and Power Department," City of Kingston, Ontario. C. C. Folger. Explains the system adopted and the results accomplished. Ills. 1500 w. Am Gas Lgt Jour—May 23, 1910. No. 14158.

Piling.

Concrete Piles. Fred J. Biele. Abstract of a thesis giving a comparative description of different types. Ills. 3000 w. Cornell Civ Engr—May, 1910. No. 14309 C.

Cement and Concrete for Protecting Piles in Sea Water. Ralph Barker. Considers methods of protecting timber piling, and report of sea-water experiments to determine the best resistant cement, and the methods of application at San Francisco. 2500 w. Cement—April, 1910. No. 13791 C.

Pipe Conduits.

Standard Specifications for Underground Construction Adopted by the City of Seattle, Washington. H. L. Estep. Information concerning specifications for regulating the location, methods of work, and materials used. Ills. 2500 w. Eng News—May 12, 1910. No. 13892.

Regulations.

Regulations for Reinforced-Concrete Construction (Vorschriften für Eisenbetonbauten). Erich Vossnack. Discusses the new Swiss regulations and compares them with other codes. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—April 30, 1910. No. 14243 D.

Reinforced Concrete.

The Design of Reinforced-Concrete Beams (Eisenbeton-Kontrollbalken). E. Suenson. Draws from the results of a series of tests conclusions as to the proper relation between concrete and reinforcement. Ills. 3700 w. Beton u Eisen—April 23, 1910. No. 14217 F.

Graphical Determination of the Moment of Resistance of Reinforced-Concrete Slabs and Beams (Graphische Berechnung der Widerstandsmomente von Eisenbetonplatten und -Plattenbalken). Herr von Bronneck. Mathematical demonstration of method. Ills. 2000 w. Oest Wochenschr f d Oeffentlich Baudienst—April 16, 1910. No. 14210 D.

General Post Office. Thomas A. Watson. Read before the Jun. Inst. of Engrs. Describes new buildings of reinforced concrete. 4500 w. Pub Works—Feb., 1910. No. 14177 A.

A Twenty-Eight Class School Building in Essen-Ruhr (Neubau einer 28 klassigen Gemeindeschule für die Stadt Essen-Ruhr). Rudolf Giese. Illustrated description of an interesting concrete structure.

2000 w. Beton u Eisen—April 5, 1910. No. 14212 F.

Construction of a Cement Mill for the Ehrenhausen Portland Cement Company in Retznay (Bau einer Zementfabrik für die Ehrenhausener Portlandzementwerke in Retznay, Steiermark). Mario Genel. Describes an interesting concrete mill building. Ills. 2000 w. Beton u Eisen—April 23, 1910. No. 14215 F.

Reinforced-Concrete Mortuary Chapel in Rostock-Damerow (Eisenbetonkonstruktionen der Einsegnungshalle der Friedhofsneubauten in Rostock-Damerow). J. Gaugusch. Describes a structure with an arched roof. Mathematical. Ills. 3600 w. Beton u Eisen—April 23, 1910. No. 14216 F.

See also Regulations, and Stacks, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; Water Works, under WATER SUPPLY; and Docks, under WATERWAYS AND HARBORS.

Retaining Walls.

The Theory of Earth Pressure on Retaining Walls (Zur Theorie des Erddruckes auf Stützmauern). Max Ritter. Mathematical. Ills. 2700 w. Schweiz Bau—April 9, 1910. No. 14086 B.

See also Concrete, under CONSTRUCTION.

Stacks.

Concrete Chimney Construction. Carl Weber. Illustrated account of the author's work, showing the adaptability of reinforced-concrete for chimney construction and its advantages over other types. The theory and design are also discussed. 6500 w. Cement—April, 1910. No. 13788 C.

Steel.

Framework of New 22d Regiment Armory, New York City; A Three-Hinged Arch Roof with Cantilever Skewback Supports. Illustrated description of a new application of 3-hinged arch roof framing. 1500 w. Eng News—May 5, 1910. No. 13776.

New Buildings of the Jones & Laughlin Number 14 Mill. Illustrated detailed description of interesting features of structural steel work. 2500 w. Eng Rec—May 14, 1910. No. 13905.

The New Balloon Shed at Aldershot. Drawings, illustrations, and description of army balloon sheds recently built in England. 1800 w. Engr, Lond—May 13, 1910. No. 14253 A.

Tunnels.

Completion of the Pennsylvania Railroad Tunnels and Terminal Station. Illustrations and information concerning this beautiful terminal building in New York City. 2000 w. Sci Am—May 14, 1910. No. 13886.

The Pennsylvania Railroad Terminal in New York. Illustrations and brief description of the New York tunnel extension and terminal building. 3500 w. Sci Am Sup—May 14, 1910. No. 13888.

New York Tunnel Extension of the Pennsylvania Railroad. The North River Tunnels. B. H. M. Hewett and W. L. Brown. Describes briefly the actual designs finally adopted, the actual conditions met, and the methods of construction adopted. Ills. 43000 w. Pro Am Soc of Civ Engrs—April, 1910. No. 14341 E.

The New York Tunnel Extension of the Pennsylvania Railroad. Meadows Division and Harrison Transfer Yard. E. B. Temple. Illustrated detailed description of his portion of the work. 3000 w. Pro Am Soc of Civ Engrs—April, 1910. No. 14338 E.

The Elbe Tunnel in Hamburg (Der Elbetunnel in Hamburg). A. Kroitzsch. Describes briefly the construction of two tunnels under the Elbe River. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—April 9, 1910. No. 14209 D.

Underpinning.

Underpinning a 300-Ton Column on Quicksand. Brief illustrated description of unusual reinforcement of foundations found necessary in New York City, and the methods used. 800 w. Eng Rec—May 14, 1910. No. 13909.

Waterproofing.

The Waterproofing of Extensive Railroad Bridge Floors. Illustrates and describes methods used for the extensive structures approaching the large terminal of the C. & N.-W. Ry. in Chicago. 1500 w. Eng Rec—May 14, 1910. No. 13908.

MATERIALS OF CONSTRUCTION.

Cement.

Action of Sea Water on Portland Cement. J. M. O'Hara. Gives results of investigations made by the writer on a number of brands of Portland cement subjected to the action of sea water. 1800 w. Eng Rec May 21, 1910. No. 14157.

Concrete.

The Preparation of Concrete; From a Selection of Materials to Final Deposition. Harry Franklin Porter. Discusses the materials, their treatment, the function of cement, etc. 1800 w. Cornell Civ Engr—May, 1910. No. 14310 C.

The Effects of Sewage and Sewage Gases on Portland Cement Concrete. Sidney H. Chambers. Abstract of an article read before the Concrete Inst., London. Describes briefly the conditions and the character of the sewage, and the investigations that seem to prove that under certain conditions the gases cause disintegration. 3500 w. Archt, Lond—April 29, 1910. No. 13837 A.

Paints.

Paint for Iron and Steel. Frank Neal. Gives results of practical experience. 1500

We supply copies of these articles. See page 647.

w. Jour Assn of Engng Soc's—April, 1910. No. 14324 C.

Reinforced Concrete.

Reinforced Concrete and Steel Frame Buildings. F. E. G. Badger. Discusses the value of concrete as a material for encasing steel frames, and of reinforced-concrete for construction. 1800 w. Cement—April, 1910. No. 13790 C.

Reinforced Concrete Columns. Peter Gillespie. A report of experimental work, and statement of inferences from evidence obtained. Ills. 3000 w. Ap Sci—April, 1910. No. 14283 C.

Spirally Armored Concrete. A letter from A. Considère, giving a critical review of an article by W. Noble Twelvetrees which discussed the tests made by Prof. Arthur N. Talbot. 3000 w. Engng—May 6, 1910. No. 13977 A.

Concrete with Spiral Reinforcement (Der umschnürte Beton). A discussion by M. Considère of the results of the tests by Prof. Talbot on spirally reinforced columns. Ills. 3500 w. Beton u Eisen—April 23, 1910. No. 14218 F.

Timber Preservation.

The New Timber Treating Plant of the Eppinger & Russell Co. at Jacksonville, Fla. Grant B. Shipley. Illustrated description of this new plant and the arrangements for handling ties, piling and lumber. 2500 w. Eng News—May 12, 1910. No. 13889.

MEASUREMENT.

Hydrographic Surveying.

The Determination of Ordinary High Water Plane on the Pacific Coast of the United States. A discussion by D. E. Hughes and Otto von Geldern. Ills. 12000 w. Jour Assn of Engng Soc's—April, 1910. No. 14320 C.

Surveying.

Primary Transverse Work of the Bronx Topographical Bureau, New York City. Describes methods and instruments used for accurate work. 1700 w. Eng News—May 19, 1910. No. 14125.

MUNICIPAL.

City Planning.

Second National Conference on City Planning and the Problems of Congestion. An outline of the proceedings at the meeting in Rochester, N. Y. 4000 w. Eng News—May 12, 1910. No. 13894.

Town Planning—A Review of the Position. Robert H. Haynes. Read before the Inc. Assn. of Munic. & Co. Engrs. Briefly considers various systems, discussing details. 5500 w. Surveyor—May 13, 1910. No. 14188 A.

The Planning of Undeveloped City Areas. Nelson P. Lewis. Read at the Conference in Rochester, N. Y. Discusses mainly the conditions of American cities. 2500 w. Eng News—May 12, 1910. No. 13895.

City Planning and Building Ordinances with Respect to Small Dwellings (Stadtbauplan und Bauordnung im Hinblicke auf Kleinwohnungen). Josef Hermann Stübben. Reviews the small-dwelling situation in various cities and countries and suggests a set of building regulations. 7000 w. Zeitschr d Oest Ing u Arch Ver—April 22, 1910. No. 14206 D.

The Relation of Buildings, Retaining Walls and Bridges, and Their Surroundings to City Development. John R. Rockart, J. D. Waterman, and C. W. Lord. A general discussion of imporvements in various cities. Ills. 4500 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14358 N.

Drainage.

Preliminary Work in the Tallahatchie Drainage District. Data from a paper by A. L. Dabney, read before the Ill. Soc. of Engrs. & Surv. concerning a district in the alluvial valley of the Mississippi River. 2200 w. Eng Rec—April 30, 1910. No. 13629.

The Drainage of the Mantovano-Reggiano District (La Bonifica dell' Agro Mantovano-Reggiano). Describes an extensive drainage system in this part of Italy. Ills. 3200 w. Monit Tech—April 20, 1910. No. 14041 D.

Pavements.

Suggestions for a Rational Formula for Street Pavement Crowns. G. B. Zahniser. Gives various rules and formulae available, with comments and suggestions. 2000 w. Eng News—May 5, 1910. No. 13775.

The Use of Concrete in the Construction of Pavements. James Pearson. Read before the Can. Cement Assn. Shows the important part Portland Cement or concrete is taking in improving the quality of pavements. 2500 w. Can Engr—April 29, 1910. No. 13641.

Wood Paving. James P. Norrington. Presents an account of wood carried out and the duration of the pavements. 2000 w. Surveyor—April 22, 1910. No. 13720 A.

A Metallic Plug for Wood-Block Pavements (Un Tampon métallique pour le Pavage en Bois). M. P. Toulon. Describes a device used in Paris for preventing deformation of wood pavements through expansion of the blocks. Ills. 1200 w. Bul Soc d' Encour—March, 1910. No. 14008 G.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. Illustrates and describes types of destructors. 2000 w. Munic Engng—May, 1910. No. 14272 C.

Refuse Disposal in Milwaukee. Fred S. Sly. An account of methods and plants used during the past thirty years, with illustrated description of present plant and its working. 5500 w. Munic Jour & Engr—May 4, 1910. No. 13756.

We supply copies of these articles. See page 647.

Roads.

Road Administration and Maintenance. Logan Waller Page. The subject is treated from the economic and administrative points of view. 3500 w. Jour Fr Inst—May, 1910. No. 14292 D.

Destructive Action of Motor Traffic on Road Surfaces and Methods of Construction to Prevent It. W. H. Fulweiler. Ills. Discussion. 9600 w. Pro Engrs' Club of Philadelphia—April, 1910. No. 14270 D.

The Road Question from the Users' Point of View. R. J. Mecredy. Read before the Irish Road Cong. Describes conditions in Ireland. 4000 w. Surveyor—May 13, 1910. No. 14189 A.

Trunk Roads. M. A. Ennis. Read before the Irish Road Congress. Considers their construction, maintenance and control. 2500 w. Surveyor—April 22, 1910. No. 13722 A.

Suitable System of Public Highways for the South. Archer B. Hulbert. Describes condition of the Southern roads and discusses the steps that should be taken for their improvement. 4500 w. Mfrs' Rec—May 19, 1910. No. 14102.

The Highway System of Los Angeles County, California. Burt A. Heinly. An illustrated account of the extensive improvements in progress, describing methods, and structures of interest. Ills. 3500 w. Munic Engng—May, 1910. No. 14273 C.

Economical Supply of Road Metal. John W. Leebody. Read before the Irish Road Congress. Gives an account of methods and results from direct ownership of a quarry. 2500 w. Surveyor—April 22, 1910. No. 13723 A.

Up-to-Date Roads. R. O. Wynne-Roberts. Refers only to macadamized roads under the classification of national, county, urban, and rural, considering each in detail. 4000 w. Soc of Engrs—May 2, 1910. No. 14187 N.

Sand-Clay Road Construction in Kansas and Some Data on Its Cost. W. S. Gearhart. Abstract of a paper read at the Missouri Highway Engrs. Assn. 2000 w. Engng-Con—May 18, 1910. No. 14118.

Road-Crust Construction. Jos. Mathison. An account of results obtained with a road surfaced with Ferromac. 3000 w. Surveyor—April 22, 1910. No. 13721 A.

The Use of Tar on Roads. A. D. Whittaker. Read before the So. Gas Assn. Describes work in the vicinity of Atlanta, Ga., and the preparation of materials, cost, etc. Ills. 7000 w. Pro Age—May 16, 1910. No. 13933.

Tar-Macadam: A Plea for Standardization. J. Walker Smith. Discusses the advantages and disadvantages of pitch macadam, and tar-concrete, and the tests applied, etc. 12000 w. Surveyor—April 22, 1910. No. 13719 A.

The Steam Rolling of Roads. E. A. Hackett. Read before the Irish Road Cong. Deals with advantages and effectiveness of steam rolling. 2000 w. Surveyor—May 13, 1910. Serial. 1st part. No. 14190 A.

Convex, Concave and Centre-Channel Roads. Harold G. Turner. Considers the pros and cons of each system. 2000 w. Surveyor—April 22, 1910. No. 13718 A.

See also Commercial Vehicles, under MECHANICAL ENGINEERING, AUTOMOBILES.

Sanitary Stations.

Public Sanitary Station at Brookline. Alexis H. French. Illustrated description of a structure of Portland cement concrete. 700 w. Jour Assn of Engng Soc's—April, 1910. No. 14321 C.

Public Sanitary Station at Lawrence. Arthur D. Marble. Illustrated description of a concrete structure. 2200 w. Jour Assn of Engng Soc's—April, 1910. No. 14322 C.

Sanitation.

The Ontario Board of Health Experimental Plant. F. H. Chesnut. Describes the plant and its work. Ills. 2500 w. Ap Sci—April, 1910. No. 14282 C.

The Holding Method of Milk Pasteurization. Charles E. North. An account of the evolution of this method of protecting the milk supply, with a brief description of the apparatus now used and the results obtained. Also editorial. 4500 w. Eng News—May 12, 1910. No. 13896.

Municipal Sanitation (La Réglementation de l'Habitation au Point de Vue de l'Hygiène). Maurice Bellom. An outline of the regulations governing the condemnation of unsanitary buildings in France, Belgium and England. 3300 w. Génie Civil—April 2, 1910. No. 14026 D.

Sewage Disposal.

The Royal Commission on Sewage Disposal. A review of Appendix IV to the Fifth Report of the Royal Commission on Sewage Disposal. 2500 w. Engr, Lond—April 22, 1910. Serial. 1st part. No. 13732 A.

Sewage Disposal Ideals. W. C. Easdale. Defines the ideals that should be aimed at in tanks, filters, distribution, etc. 3500 w. Can Engr—May 20, 1910. No. 14143.

Removal of Organic Matter from Sewage by Screens and Tanks. Emil Kuichling. Gives data relating to the efficiency of fine screens, showing the benefits, and that the cost is much less than that of sedimentation. 4000 w. Eng Rec—May 21, 1910. No. 14153.

Sewage Disposal Plant at Lancaster, New York. Plans and description of a plant for a city of 4000 population, comprising grit chambers, septic tanks and contact beds. 1000 w. Eng Rec—May 7, 1910. No. 13799.

We supply copies of these articles. See page 647.

Sewage Disposal Works at Indiana, Pennsylvania. Illustrated description of works executed in plain and reinforced-concrete for a town of about 8000 population. 2000 w. Eng Rec—April 30, 1910. No. 13628.

Leicester Sewage Works. E. George Mawley. Describes a system of purification by sedimentation tanks, single contact beds and broad irrigation on clay land. 4500 w. Surveyor—April 29, 1910. No. 13847 A.

Glasgow Sewage Disposal. Illustrated description of the Shieldhall sewage works and main drainage scheme. 3500 w. Engr, Lond—May 13, 1910. No. 14256 A.

The Glasgow Main-Drainage Works. Illustrated description of the extensive scheme for the purification of the sewage of the city, so that it may safely be passed into the River Clyde. 4800 w. Engng—April 29, 1910. Serial. 1st part. No. 13852 A.

See also Purification, under WATER SUPPLY.

Sewer Pipe.

Some Experiments on the Cost and Durability of Cement Drain Tile. W. H. Day. Read before the Can. Cement & Concrete Assn. Gives the cost of making cement tile by hand, and a report of solubility tests. 2500 w. Cement—April, 1910. No. 13789 C.

Sewers.

Methods of Constructing the Western Ave. Sewer, Chicago, Ill. Illustrated description of the methods employed in constructing a concrete sewer, without reinforcement. 1600 w. Engng-Con—May 4, 1910. No. 13757.

WATER SUPPLY.

Analysis.

Chemistry, and the Conservation of Our Water Resources. Prof. Marston Taylor Bogert. Shows the importance of purity of the water supply, and the services of the chemist in determining its quality. 1200 w. Jour Fr Inst—May, 1910. No. 14294 D.

Aqueducts.

The Progress of the Los Angeles Aqueduct. An illustrated account of this great engineering work, and the rapid progress made in its construction. 3500 w. Eng Rec—May 21, 1910. No. 14147.

The Los Angeles Aqueduct: Structural Details, Economic Studies, Working Organization, and Service Constructions. Outline of the development and character of this great engineering work and of its management. Ills. 5500 w. Engng-Con—May 4, 1910. No. 13758.

Dams.

Some Recent Considerations of Stresses in High Masonry Dams. Charles E. Morrison. Outlines the analysis given in a paper by L. W. Atcherley "On Some Disregarded Points in the Stability of Masonry Dams," calling attention to some of the discussion which followed, in order to indicate the status of the theory involved in the design of such structures. 7000 w. Sch of Mines Qr—Jan., 1910. No. 14301 D.

Discharge Coefficients.

Coefficients of Discharge for Flow Through a Notch in the McCall Ferry Dam. R. H. Anderson. Illustrates and describes experiments made to determine a coefficient of discharge to be applied in estimating the flow through similar openings. 1400 w. Cornell Civ Engr—May, 1910. No. 14307 C.

Filtration.

Water Filtration in Theory and Practice. George C. Whipple. Deals with the requirements of a water supply, methods of purification, theory of filtration, coagulation, aeration, disinfection, etc. Ills. 7500 w. Can Engr—May 6, 1910. No. 13816.

Toronto Filtration Plant. Francis F. Longley. Illustrated description of a plant for purifying lake water. 2200 w. Munic Jour & Engr—May 18, 1910. No. 14112.

Fort William.

Fort William Water Supply. H. Sydney Hancock, Jr. An illustrated account of an undertaking carried out under unfavorable conditions. Especially describes the difficulties encountered. 33500 w. Can Soc of Civ Engrs—1910. No. 14297 N.

Impurities.

Lead in Drinking Water. A discussion of the troubles in Great Britain from the moorland waters and lead piping. 2000 w. Engr, Lond—April 29, 1910. No. 13858 A.

Irrigation.

The Economy Resulting from the Use of the Level on the Farm. George M. Lewis. Suggestions for increasing the efficiency of water in irrigated districts. 1400 w. Jour Assn of Engng Soc's—April, 1910. No. 14323 C.

Field Location of Canals for Irrigation. L. R. Balch. Describes the preliminary and final location. 1500 w. Pub Works—Feb., 1910. No. 14178 A.

Method of Lining an Irrigation Canal With Cement Plaster, With a Discussion on Cement Plaster versus Lime and Cement Plaster. W. D'Rohan. Describes work on a canal of the Standley project, Colorado. 2000 w. Engng-Con—May 18, 1910. No. 14119.

London.

London Water Supply. A discussion of the future water supply and explanation of the "progressive scheme" adopted. 2500 w. Engr, Lond—April 29, 1910. No. 13862 A.

Panama Canal.

Hydraulics of the Chagres River. Gen. Henry L. Abbot. Shows that the water supply for the Panama Canal will be fully adequate for its operation. 3000 w. En-

gineering Magazine—June, 1910. No. 14380 B.

Pipe Corrosion.

Deoxidizing Water to Prevent Corrosion of Steel Mains. An account of an investigation instituted by the Australian Government to determine the best methods for checking the corrosion of the steel mains of the Coolgardie water-works and the recommendations. 2500 w. Eng Rec—May 21, 1910. No. 14154.

Pipe Flow.

Friction Head Hydraulics and Pipe Flow Diagrams. Ernest W. Schoder. Considers the flow of water in pipes from the standpoint of friction head. Mathematical. 2200 w. Cornell Civ Engr—May, 1910. No. 14308 C.

Pipe Lines.

The Hydrostatic Chord. Raymond D. Johnson. With discussion of its application in the design of large pipes of reinforced concrete. 1500 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14334 F.

Purification.

Some Recent Developments in the Purification of Public Water Supplies. R. S. Lea. Illustrates and describes improvements in apparatus used, in mechanical filters, and in methods of purifying the water supply. 7000 w. Can Soc of Civ Engrs—April 28, 1910. No. 14298 N.

Some Phases of the Water Purification Problem—As Related Especially to Sacramento Conditions. Charles Gilman Hyde. Considers the available sources, the requirements, rapid sand filtration and its efficiency, use of coagulants, sterilization, etc. 8500 w. Cal Jour of Tech—May, 1910. No. 14304.

The Disinfection of Water and Sewage. Earle B. Phelps. Brief review of processes developed and the history of chemical disinfection of water. Also the disinfection of sewage and the cost. General discussion. 7000 w. Pro Engrs' Club of Phila—April, 1910. No. 14271 D.

Reservoirs.

Reconnaissance Method of Determining the Volume of Reservoir Sites. Horace W. Sheley. Gives the writer's method of obtaining such data, claiming greater accuracy than in the usual estimate. 5000 w. Eng Rec—April 30, 1910. No. 13625.

Sterilization.

Sterilization of Water. Messrs. Walden and Powell. From a paper before the Am. Water-Works Assn. describing experiments and methods at Baltimore, Md. 3000 w. Munic Engng—May, 1910. No. 14274 C.

Water Towers.

A Concrete Water Tower (Chateau d'Eau en Beton armé). Describes a structure at Ixelles, near Brussels. Ills. 1600 w. Génie Civil—April 9, 1910. No. 14028 D.

Water Works.

The Ripon Water-Works Decision. Gives an outline of a method of apportioning the expenses. 3000 w. Eng Rec—April 30, 1910. No. 13631.

Reinforced Concrete Water Works Construction. Frank C. Perkins. Illustrations and description of features of the Indianapolis water-works. 1200 w. Sci Am—May 7, 1910. No. 13784.

Wells.

Evolution of Well-Drilling Machinery. John L. Cowan. An account of early methods and the first drilling through solid rock. 2200 w. Min & Sci Pr—May 14, 1910. No. 14132.

WATERWAYS AND HARBORS.

Barge Canal.

Construction of the New York State Barge Canal Through Little Falls. D. A. Watt. An illustrated article describing conditions and work at this point. 4500 w. Eng Rec—May 7, 1910. No. 13796.

Chicago.

The Chicago Harbor Problem. Report of the Committee, A. Bement, Chairman, and Messrs. W. L. Abbott, L. E. Ritter, E. C. Shankland and Willard A. Smith. Also general discussion. 6000 w. Jour W Soc of Engrs—April, 1910. No. 14326 D.

Docks.

A Reinforced Concrete Dock. A. P. Brown. Illustrated description of a recently completed dock at Detroit, Mich. 1200 w. Eng Rec—May 21, 1910. No. 14155.

England.

The Relation of Canals to Railway Transport. S. Whettal. A discussion of the water question in England. 2000 w. Cassier's Mag—May, 1910. No. 13954 B.

Germany.

Waterway Development in Wurtemburg (Württembergische Grossschiffahrtspläne). H. Werner. A brief review of the Danube-Neckar and Danube-Bodensee canal projects. Ills. 2000 w. Glasers Ann—April 15, 1910. No. 14203 D.

Lighthouses.

Lighthouse Practice in the Netherlands (Eenige Mededeelingen over de nederlandsche Kustverlichting). B. A. Verhey. A general review of coast-lighting practice. Ills. 6000 w. De Ingenieur—April 2, 1910. No. 14248 D.

Locks.

The Canadian Hydraulic Lift Locks. Walter J. Francis. Illustrated description of the locks on the Trent Canal system. 3000 w. Engr, Lond—April 29, 1910. Serial. 1st part. No. 13857 A.

See also Concrete, under CONSTRUCTION.

Mississippi River.

An Emergency in the Life of a River. Robert S. Taylor. A discussion of the

We supply copies of these articles. See page 647.

Mississippi River below Cairo, giving reasons why the Government should be responsible for its regulation. Maps. 5000 w. Eng News—May 5, 1910. No. 13780.

Panama Canal.

Condensed Facts on the Panama Canal. Information based on the authority of the Isthmian Canal Commission. 2500 w. Engng-Con—May 18, 1910. No. 14120.

Piers.

Coaling Pier at Hampton Roads. Warren O. Rogers. Illustrated description of the large electrically-operated pier at the seaboard-terminal of the Virginia Ry. 1200 w. Power—May 17, 1910. No. 13940.

Pollution.

A British Decision Regarding River Pollution. Concerning an action brought to restrain the discharging of sewage effluent into the river Tame. 2500 w. Eng Rec—April 30, 1910. No. 13627.

The North Shore Channel of the Sanitary District of Chicago. C. R. Dart. Illustrated detailed description of work for the protection from sewage pollution of Lake Michigan, north of Chicago. 6000 w. Eng Rec—May 14, 1910. No. 13903.

Stipulations Between the United States and the Passaic Valley Sewerage Commission Regarding the Discharge of Sewage into New York Bay. 1500 w. Eng News—May 12, 1910. No. 13893.

River Improvements.

The Policy of River and Harbor Improvements. Comments taken from remarks of Senator Burton criticizing the policy of conducting such improvements. 2800 w. Eng Rec—May 14, 1910. No. 13904.

Soil Erosion.

The Behavior of a Stream Carrying Sand and the Effect of Sand on the Measurement of Bottom Velocity. E. C. Murphy. Describes interesting phenomena of sand transportation and discusses the effect on the measurement of bottom velocity. Diagrams. 1500 w. Eng News—May 19, 1910. No. 14123.

St. Lawrence River.

The Problems of Winter Navigation on the St. Lawrence River. H. T. Barnes. Describes some icebreakers and their work, ice-forming problems, keeping channels open, etc., and gives results of the work of the Flood Commission. Ills. 6500 w. Can Engr—May 13, 1910. No. 13934.

Water Powers.

Water Power of the South. H. A. Von Schon. Aims to show that there is sufficient power available to supply all the power needs of Southern manufacturers. Ills. 1700 w. Mfrs' Rec—May 12, 1910. Serial. 1st part. No. 13873.

MISCELLANY.

Building Transfer.

Moving a 200-Ton Pier-Shed on Scows. Illustration and description of the transfer of a large steel shed in New York City. 900 w. Eng Rec—May 21, 1910. No. 14150.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Printing Telegraphs.

Electric Printing Telegraphs in the Berlin Police Headquarters (Der elektrische Spaltenfernd rucker im Berliner Polizeipräsidium). Illustrated description. Serial. 1st part. 2000 w. Elektrotechniker—April 25, 1910. No. 14219 D.

Radiotelegraphy.

Wireless Telegraph Apparatus for Contestants of the Glidden Tour. René Homer. Illustrates and describes the arrangements. 1000 w. Sci Am—May 14, 1910. No. 13883.

New Methods of Transmission Employed in Wireless Telegraphy. G. Ferrié. Reviews the methods tried to obtain security, and describes a simple wave meter invented by the author. 1800 w. Elect'n, Lond—May 6, 1910. No. 13963 A.

New Radiotelegraphic Systems (Les nouveaux Procédés de Télégraphie sans Fil). H. Marchand. An illustrated description of the Peukert system. 1500 w. L'Eleen—April 2, 1910. No. 14017 D.

See also Frequency, under MEASUREMENT.

Telegraphy.

Telegraphy and Telephony: Professor Fleming's Postgraduate Lectures. G. B. Dyke. Gives the examination questions submitted by Prof. J. A. Fleming at the close of his lectures, with solutions by the author. 500 w. Elec Engr, Lond—May 13, 1910. No. 14182 A.

Electrostatic Charging of Telegraph Wires by Locomotives. Abstract of an article by R. W. Weightman concerning peculiar electrostatic phenomena. 1500 w. Engr, Lond—April 22, 1910. No. 13736 A.

Telemechanic.

Telemechanic (Télémécanique). J. A. Montpellier. The first part describes the system devised by Baron d'Ivry. Ills. Serial. 1st part. 2000 w. L'Eleen—April 30, 1910. No. 14021 D.

Telephone Lines.

Long Underground Telephone Lines on Pupin System. A. Ebeling. Describes in detail a special series of experiments which seem to show that no hindrance now exists against the placing of telephone cables underground. 4500 w. Elec Wld—May 12, 1910. No. 13916.

We supply copies of these articles. See page 647.

Aerial Telephone Lines on the Pupin System. B. S. Cohen. Notes on a paper read by A. Ebeling. Gives particulars of the loading adopted on lines in Germany, and of the results. Ills. 1700 w. Elect'n, Lond—May 6, 1910. No. 13965 A.

Telephone Relays.

A Telephone Relay. S. G. Brown. Describes the present form of the author's telephone relay, which magnifies the feeblest currents about 20 times. Also describes an electric stethoscope. Ills. 4500 w. Inst of Elec Engrs—May, 1910. No. 13959 N.

Telephony.

Some Notes on Telephony. H. Harrison. General information pertaining to telephony which is not readily available. 2200 w. Sib Jour of Engng—May, 1910. No. 14316 C.

Discussion on "Modern Automatic Telephone Apparatus," New York, Feb. 11, 1910. Discussion of the paper of W. Lee Campbell. 8200 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14350 F.

New Telephone Systems (Nieuwere Telefoonstelsels). C. L. van der Bilt. Describes a number of systems, with illustrations from practice in the Netherlands. Ills. 20000 w. De Ingenieur—April 30, 1910. No. 14259 D.

See also Telegraphy, under COMMUNICATION.

Telephotography.

Telegraphy of Photographs, Wireless and by Wire. T. Thorne Baker. Explains the telectrograph system as used by the *Daily Mirror*, refers to the work of Prof. Korn with selenium cells, and gives particulars of wireless transmission. 5000 w. Elect'n, Lond—April 29, 1910. No. 13844 A.

The Thorne-Baker Tele-Photographic Apparatus. Illustrated description of an instrument for transmitting pictures with and without wires. 1500 w. Sci Am—May 21, 1910. No. 14127.

DISTRIBUTION.

Fault Location.

Simple Tests for Locating Faults in Circuits. W. T. Ryan. Describes simple galvanometer tests. Ills. 500 w. Power—May 24, 1910. No. 14266.

Insulation.

Tests on Mica Tubes. Dr. K. Fischer. Abstract translation from *Elec. Zeit.* Gives comparative tests showing the superiority of a new type of mica tube containing no paper and practically no binding material. 800 w. Elect'n, Lond—May 6, 1910. No. 13964 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The Single-Phase Commutator Generator. Val. A. Fynn. Characteristics of the synchronous, single-phase, shunt, induction generator with mixed excitation. 3000 w. Elec Wld—May 26, 1910. Serial, 1st part. No. 14391.

Leakage Reactance. J. Rezelman. Gives test results of the reactance of a four-pole stator winding with special end connections, confirming conclusions of an earlier article. Ills. 800 w. Elect'n, Lond—April 29, 1910. No. 13845 A.

Parallel Operation of Three-Phase Generators with Their Neutrals Interconnected. George I. Rhodes. Shows that alternators as usually designed and built are not suited for parallel operation with their neutrals interconnected, but that it seems possible to build generators which can operate properly. 4500 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14346 F.

A. C. Motors.

Calculation of the Overhang Leakage in Three-Phase Motors. Dr. M. Kloss. Abstract of an article in the *Elec. und Maschinenbau.* Shows how the leakage of the coil ends of an induction motor or alternator can be found. 800 w. Elect'n, Lond—April 29, 1910. No. 13846 A.

Adjustable Three-Phase Operation and Its Laws (Die regulierbaren Drehstrom-Getriebe und ihre Gesetze). Frederich Schmidt. Reviews the development of the adjustable three-phase motor. Ills. 6000 w. Elektrotech u Maschinenbau—April 10, 1910. No. 14226 D.

Armatures.

Detection of Faults in Small Motor Armatures. C. Nosrac. Illustrates and describes devices successfully used by the writer. 1300 w. Elec Wld—May 19, 1910. No. 14166.

Commutation.

Commutation Phenomena and Magnetic Oscillations Occurring in Direct-Current Machines. G. W. Worrall. Abstract of a paper before the Birmingham Sec. of the Inst. of Elec. Engrs. Discusses the theory of commutation and describes research work. Ills. 3000 w. Elect'n, Lond—May 13, 1910. Serial. 1st part. No. 14185 A.

Commutation in Direct Current Machines. C. L. Arnold. Read before the Arc Works Engng. Soc., Chelmsford. Discusses methods of suppressing sparking, self-induction, the properties of the brush, etc. Diagrams. 4000 w. Elec Engr, Lond—April 29, 1910. No. 13840 A.

Commutation (La Commutation). Marius Latour. A discussion of the theory of commutation based on recent literature. Ills. 7000 w. Bul Soc Int d Elecns—April, 1910. No. 14047 F.

D. C. Dynamos.

Reconstruction of Direct-Current Machines. W. B. Clayton and James W. Craig. Illustrates and describes the application of commutation poles to motors and generators already installed. 2500 w. Elec Wld—May 5, 1910. No. 13773.

We supply copies of these articles. See page 647.

D. C. Motors.

See D. C. Dynamos, under DYNAMOS AND MOTORS.

Iron Losses.

Experimental Investigations on Iron Losses and Mechanical Forces on Windings (Experimentelle Arbeiten. I. Ueber Eisenverluste. II. Ueber mechanische Kräfte an Wickelköpfen). Herr Niethammer. An introduction to Herr Czepek's paper. Ills. 1500 w. Elektrotech u Maschinenbau—April 17, 1910. No. 14228 D.

Comparative Investigations of Iron Losses Due to Single-Phase, Rotary and Magneto-Static Magnetization (Vergleichende Versuche über Eisenverluste durch Wechsel-, drehende und magnetostatische Magnetisierung). R. Czepek. Results of extended experiments. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—April 17, 1910. No. 14229 D.

Vertical Motors.

Vertical Motors, with Special Reference to Bearings (Ueber Vertikalmotoren mit besonderer Berücksichtigung der Lagerkonstruktionen). J. Fischer-Hinnen. Illustrated description of various types. 3500 w. Elektrotech u Maschinenbau—April 24, 1910. No. 14230 D.

ELECTRO-CHEMISTRY.

Electric Furnaces.

Improving the Output and Efficiency of Existing Electric Furnaces. Carl Hering. Describes simple methods and rules by means of which it may be determined whether improvements in electric smelting can be made by changes in the electrodes. 2000 w. Met & Chem Engng—May, 1910. No. 13700 C.

Chemical Reactions at Electrodes. Reston Stevenson. Reviews electrochemical reactions in liquid solutions, particularly in aqueous solutions. 4000 w. Met & Chem Engng—May, 1910. No. 13691 C.

Electrolysis.

The Development of the Theories of Electrolysis and Polarization (Die Entwicklung unserer Kenntnisse über Elektrolyse und Polarisation). M. Le Blanc. A review of their development and present form. Ills. 5200 w. Zeitschr d Oest Ing u Arch Ver—April 29, 1910. No. 14208 D.

Electrometallurgy.

Electric Furnaces in Non-Ferrous Metallurgy. Joseph W. Richards. Discusses in detail the use of electric furnaces in the operations of non-ferrous metallurgy. 2000 w. Met & Chem Engng—May, 1910. No. 13688 C.

Electroplating.

Modern Electroplating Plant. Brief description of the plant at the works of the National Cash Register Co., Dayton, Ohio. Ills. 1500 w. Met & Chem Engng—May, 1910. No. 13699 C.

Laboratories.

The Electrical Testing Laboratories and Electrochemistry. Clayton H. Sharp. Describes in detail the points in the equipment most important for electrochemical work. Ills. 5500 w. Met & Chem Engng—May, 1910. No. 13692 C.

ELECTRO-PHYSICS.

Dielectrics.

The Polarization of Dielectrics in a Steady Field of Force. W. M. Thornton. Abstract of a paper before the Phys. Soc. An account of experiments in the polarization of dielectric ellipsoids and cylinders suspended in a steady electric field. 3000 w. Elect'n, Lond—April 22, 1910. No. 13712 A.

Electrification.

Dependence of the Weight of a Body on Its State of Electrification. L. Southerns. Abstract of a paper read before the Cambridge Phil. Soc. Experimental investigation to detect change of weight due to electrification. Ills. 2000 w. Elect'n, Lond—April 22, 1910. No. 13713 A.

Electrotherapeutics.

High-Frequency Currents in Medicine and in Wireless Telegraphy (Haute Fréquence médicale et Télégraphie sans Fil). M. d'Arsonval. Describes electrotherapeutic devices borrowed from wireless telegraphy. Ills. 5500 w. Bul Soc Int d Elecns—April, 1910. No. 14046 F.

Induction Coils.

On the Effect of Shunting Inductive Coils. G. W. O. Howe. Shows geometrically that although the effective resistance may be increased by shunting a highly inductive coil by a non-inductive resistance, the impedance is not increased. 500 w. Elect'n, Lond—April 22, 1910. No. 13711 A.

Magnetic Properties.

Magnetic Properties of Materials. Charles P. Steinmetz. Arguments on behalf of the theory that magnetic alloys owe their ferro-magnetic properties to some particular constituent or constituents. Also editorial. 1300 w. Elec Wld—May 12, 1910. No. 13917.

Retentivity of Magnet Steels. A summary of results of a series of experiments in Austria. 1500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13997 A.

GENERATING STATIONS.

Accumulators.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE; and Motor Cars, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Central Stations.

Reconstruction of a Country Plant. Parker H. Kemble. Illustrated description work made necessary by the consolidation of two Connecticut companies. 3300 w. Elec Wld—May 5, 1910. No. 13772.

We supply copies of these articles. See page 647.

Electricity Supply and Transmission in St. Louis. Illustrated description of the system of the Union Electric Light and Power Company. 6500 w. Elec Rev, N Y —May 21, 1910. No. 14146.

Union Electric Light and Power Company. Illustrated detailed description of the electrical generation and distribution of energy for lighting and motor service in the city of St. Louis and suburbs. Also of the administrative and business methods. 19000 w. Elec Wld—May 19, 1910. No. 14163.

Electrical Department of the Metropolitan Street Railway, New York. An illustrated statement of the most important work accomplished by this department since 1907. 2500 w. Elec Ry Jour—May 21, 1910. No. 14129.

The Danville Central Station System. Illustrated description of the transmission system, power plant, and operating features. 2000 w. Elec Wld—May 26, 1910. No. 14390.

Costs.

Cost of Generating and Distributing Electricity for Lighting and Power, New York Edison Co. An analysis of the cost to the New York Edison Co. which produces nearly 70 per cent of the electricity used for lighting in New York City. 1800 w. Engng-Con—May 11, 1910. No. 13912.

Economics.

Central-Station Output and Productive Economy. Discusses the advantages of a large output, giving comparative results. 2000 w. Elec Wld—May 19, 1910. No. 14162.

Fire Hazards.

Common Fire Hazards of Electric Light and Power Plants. W. J. Canada. Remarks on station construction and on preventable fire hazards in stations. 2200 w. Elec Wld—May 19, 1910. No. 14168.

Hydro-Electric.

A General Review of Hydroelectric Engineering Practice. Frank Koester. Third article of a series giving an illustrated discussion of turbines, water wheels, and mechanical equipment of the power plant. 4000 w. Engineering Magazine—June, 1910. No. 14378 B.

Some Considerations in Selecting Equipment for Hydro-Electric Plants. M. H. Collbohm. Calls attention to points in the design, selection and arrangement of the various parts. 3500 w. Elec Age —April, 1910. No. 13935.

Commercial Aspects of Hydro-Electric Plants (Geschäftliche Aussichten von hydraulisch betriebenen Elektrizitätswerken). W. v. Winkler. Considers the economics of large plants. Ills. 3200 w. Elektrotech u Maschinenbau—April 3, 1910. No. 14225 D.

Economical Utilization of Water Power in Lighting and Power Systems of Large Cities (Die Wirtschaftliche Ausnutzung der Wasserkräfte in den Beleuchtungs- und Kraftverteilungsanlagen grösserer Städte). Herr Norberg-Schulz. A discussion of load factor and power cost. Ills. 3000 w. Die Turbine—April 5, 1910. No. 14090 D.

The Schaghticoke Hydro-Electric Plant (L'Installation hydro-électrique de Schaghticoke, Etats-Unis). Richard Muller. Describes this plant on the Hoosic River and gives results of tests. Ills. 4000 w. Tech Mod—April, 1910. No. 14013 D.

Hydroelectric Plant of the Central Georgia Power Company. Illustrates and describes a plant for developing the power of the Ocmulgee River. 2000 w. Eng Rec—May 14, 1910. No. 13907.

Richmond & Chesapeake Bay Plant. Warren O. Rogers. Illustrated description of a combination water power and steam plant. 1400 w. Power—May 3, 1910. No. 13668.

The Brattleboro Hydro-Electric Plant. Lauriston Fredericks. Illustrated description of a power development on the Connecticut River, utilizing a head of about 15 feet. 1000 w. Cassier's Mag—May, 1910. No. 13949 B.

Hydro-Electric Installations of Sweden. Aubrey V. Clayton. Explains the characteristics of the country and describes typical installations. Ills. 1200 w. Inst of Elec Engrs—April, 1910. No. 13708 N.

An Electric Power Plant on the Löntsch (Elektrizitätswerk am Löntsch). J. Ehrensperger. An exhaustive description of the preliminary investigations and construction of a power development in Switzerland. Ills. Serial. 1st part. 3500 w. Schweiz Bau—April 16, 1910. No. 14087 B.

The Cervara Power Plant and Power Transmission to Narni (Das Kraftwerk Cervara und die elektr. Kraftübertragung nach Narni). L. Pasching. Illustrated description of this plant in Italy. 3500 w. Schweiz Bau—April 2, 1910. No. 14085 B.

Cassibili Electric Power Works, Sicily. Illustrations, with brief description of a recent hydro-electric plant. 500 w. Engr, Lond—May 6, 1910. No. 13983 A.

Isolated Plants.

Electric Power at Messrs. Cammell, Laird & Co.'s Trammere Works. Illustrated detailed description. 1500 w. Elec Rev, Lond—May 13, 1910. No. 14184 A.

New Plant at Birchenwood Collieries, Kidsgrove. Illustrated description of an electrical plant for the surface auxiliaries, and to a large extent for power underground. 2 plates. 2500 w. Ir & Coal Trds Rev—April 22, 1910. No. 13739 A.

Load Factors.

Average and Maximum Loads. Alton

We supply copies of these articles. See page 647.

D. Adams. A discussion of average and maximum loads in stations of various capacity. Also editorial. 2500 w. Elec Wld—May 19, 1910. No. 14167.

Protective Devices.

See same title, under TRANSMISSION.

Switchboards.

The Evolution of the Switchboard: Twenty Years Progress. Saul Lavine. Abstract of a paper read before the Pittsburg Elec. Boosters' Club. The present number considers the early skeleton switchboard and the ornamental switchboard. 1000 w. Elec Rev, N Y—May 14, 1910. Serial. 1st part. No. 13930.

High-Tension Concrete Switchboard Structures. W. R. Stinemetz. Gives conclusions from the standpoint of the erection engineer. 3000 w. Elec Jour—May, 1910. No. 14288.

Switchgear.

High-Tension Switchgear, with Special Reference to Mining and Colliery Developments. M. B. Field. Abstract of a paper read before the S. Wales Inst. of Engrs. Illustrates and describes types, explaining the uses for which they are suited. 6500 w. Ir & Coal Trds Rev—May 6, 1910. No. 14100 A.

The Koula Switch Gear for Direct-Current Public Lighting (Fernschalter für öffentliche Beleuchtung in Gleichstromzentralen, System Koula). Describes a system recently patented in Austria. Ills. 2000 w. Elektrotech u Maschinenbau—April 24, 1910. No. 14231 D.

Voltage Regulation.

Automatic Voltage Regulators for Direct and Alternating-Current Plants (Die selbsttätigen Spannungsregler für Gleichstrom- und für Wechselstrom-Kraftwerke). J. Schmidt. Describes and discusses various types. Ills. Serial. 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—April 16, 1910. No. 14237 D.

LIGHTING.

Arc Lamps.

Progress in High-Intensity Electrical Illumination (Neue Aussichten in der elektrischen Starklichtbeleuchtung). Konrad Norden. Describes recent developments in arc lamps. Ills. 7000 w. Glasers Ann—April 1, 1910. No. 14201 D.

See also Street, under LIGHTING.

Illumination.

The Distribution of Artificial Light. Frank Marshall. Scantlebury. Abstract of paper read before the Nat. Assn. of Cotton Mfrs., Boston. Describes lamps most generally used, discussing reflectors, etc. 2000 w. Elec Rev, N Y—May 7, 1910. Serial. 1st part. No. 13787.

The Luminous Efficiency of Incandescent Lamps. W. W. Coblentz. The emissivities of filaments are considered from the standpoint of their reflectivities. 2500 w. Elec Wld—May 19, 1910. No. 14169.

Calculation of Illumination by the Point-by-Point Method. Alfred A. Wohlauer. Refers to the paper by Albert F. Parks on the graphical method of calculating, and gives a simpler way developed by the author. 1200 w. Elec Wld—May 12, 1910. No. 13919.

The Bearing of Reflection on Illumination. A. S. McAllister. Theoretical considerations relating to the limits of reflection as disclosed by the absorption-of-light method of calculating illumination. Also editorial. 3000 w. Elec Wld—May 26, 1910. No. 14393.

Reflectors for Incandescent Lamps. Thomas W. Rolph. Explains the advantages of reflectors and gives considerations in regard to their use. 3000 w. Elec Jour—May, 1910. No. 14285.

Show Window Illumination. J. R. Cravath. Shows the waste due to inefficiency of reflecting surfaces, poor reflectors or those unsuited to the purpose. Ills. 1500 w. Cent Sta—May, 1910. No. 13938.

Notes on Office Lighting. C. E. Clewell. Describes experiment, for the purpose of determining the arrangement and number of lamps required to furnish the best illumination. 2000 w. Elec Jour—May, 1910. No. 14286.

Incandescent Lamps.

A Convenient Lamp Bank for Testing Purposes. R. H. Fenkhausen. Illustrates arrangements to give different voltages. 600 w. Power—May 17, 1910. No. 13942.

See also Transformers, under TRANSMISSION.

Photometry.

The Direct Measurement of Mean Spherical Candle-Power by Diffusion Methods. W. E. Sumpner. Abstract of a paper before the Ill. Engng. Soc. Discusses the action of the Ulbrecht globe and its accuracy, comparing with a rectangular box surrounding the lamp and lined with white reflecting surface. 1800 w. Elect'n, Lond—April 22, 1910. No. 13715 A.

Searchlights.

See Military, under MECHANICAL ENGINEERING, AUTOMOBILES.

Street.

An Analysis of Illumination Requirements in Street Lighting. Arthur J. Sweet. A study of distribution, and of glare effect as applied to street lighting. Ills. 6000 w. Jour Fr Inst—May, 1910. No. 14293 D.

Improvements in Street Lighting Units. Dudley A. Bowen. Explains the results obtained by use of the flaming arc. Ills. 1200 w. Elec Jour—May, 1910. No. 14291.

Street Lighting by High Candle-Power Metal Lamps. Information from various sources concerning experience with metal filament lamps. 3000 w. Elect'n, Lond—April 22, 1910. No. 13714 A.

We supply copies of these articles. See page 647.

Street Lighting by Modern Electric Lamps. Haydn T. Harrison. Explains conditions to be met in the early installations for street lighting by electricity, referring to results at Marylebone, and the improvements possible with modern electric lamps. 6500 w. Inst of Elec Engrs—May, 1910. No. 14351 N.

MEASUREMENT.

Frequency.

Frequency and Wave-Length Measurements in Wireless Telegraphy and Telephony (Frequenzmesser und Messung der Wellenlänge in der drahtlosen Telegraphie und Telephonie). Eugen Nesper. Describes instruments and methods. Ills. Serial. 1st part. 3500 w. Elektrotech u Maschinenbau—April 10, 1910. No. 14227 D.

Instruments.

Ferrié and Carpentier Ohmmeters (Ohmmètres, Système Ferrié et Carpentier). J. A. Montpellier. Illustrated description of the instruments and their use. 1500 w. L'Eleen—April 16, 1910. No. 14019 D.

Meters.

Selecting a Watt-Hour Meter. Abstract of bulletin issued by a German firm on the subject of selection by competitive tests. Ills. 2000 w. Elec Wld—May 12, 1910. No. 13918.

Motor Testing.

The Differential Method of Testing a Direct-Current Motor for Temperature Rise and Efficiency (Die Differential-oder Zurückarbeitungsmethode zur Bestimmung der Erwärmung und des Wirkungsgrades einer Gleichstrommaschine). W. Lulofs. Describes and discusses the loading-back test. Ills. Serial. 1st part. 1400 w. Elektrotech Rundschau—April 7, 1910. No. 14221 D.

Wave Length.

See Frequency, under MEASUREMENT.

POWER APPLICATIONS.

Heating.

Recent Progress in the Construction and Application of Electrical Apparatus for Heating and Cooking (I recenti Progressi nella Costruzione e nelle Applicazioni degli Apparecchi elettrici per Riscaldamento e per Cucina). S. Herzog. Describes recent apparatus. Ills. Serial. 1st part. 2500 w. Industria—April 10, 1910. No. 14039 D.

Military.

The Applications of Electricity to Field Engineering. Col. R. E. B. Crompton. Abstract of a lecture at the Roy. Engrs' Inst. Briefly considers applications for army signalling; camp lighting, searchlights, etc.; and for power. 2500 w. Elect'n, Lond—May 6, 1910. No. 13966 A.

Theatres.

The Boston Opera House. Description of the elaborate electrical euipment. Ills. 5000 w. Elec Wld—May 12, 1910. No. 13914.

TRANSMISSION.

Alternating Current.

Paralleling Large Alternating-Current Systems. P. M. Lincoln. Considers the problem of furnishing a small amount of power from one A. C. system to another 3500 w. Elec Jour—May, 1910. No. 14289.

Three-Wire Alternating Current Circuits. Cecil P. Poole. An illustrated article showing the difference between single-phase three-wire, two-phase three-wire, and three-phase three-wire circuits. 2200 w. Power—May 10 1910. No. 13821.

Cables.

Electric Cables. F. Ferine. Considers the general phenomena of electrolysis and discusses in detail the corrosion of lead-covered cables and armored cables and the effectiveness of earthing. 3300 w. Elect'n, Lond—May 13, 1910. Serial. 1st part. No. 14186 A.

Capacity.

Capacity in Transmission Lines. H. F. Penney, R. H. Harrison, G. H. Crawford, Jr. A comparison of the various approximate assumptions of the distribution of capacity in transmission lines. 1500 w. Sib Jour of Engng—May, 1910. No. 14319 C.

Ground Detectors.

Lamp Ground Detectors for Power Circuits. J. M. Row. Illustrates four different methods of connection. 500 w. Power—May 10, 1910. No. 13822.

Insulators.

Transmission Insulators. A. S. Watts. Detailed comparison of high-tension insulators of American and European design. Ills. 500 w. Elec Wld—May 19, 1910. No. 14165.

Lightning Protection.

Lightning and Lightning Protection. Dr. Charles P. Steinmetz. An illustrated article describing the means of protecting lines and station apparatus. 2500 w. Cent Sta—May, 1910. No. 13937.

Line Design.

The Calculation of Transmission Lines (Méthode de Calcul d'une Ligne de Transmission d'Energie électrique). A. R. Garnier. Works out a complete numerical example. Serial. 1st part. 1500 w. L'Eleen—April 23, 1910. No. 14020 D.

Poles.

Concrete Poles for a Transmission Line. Illustrates and describes the design, construction and methods used for a 30,000-volt transmission line at Marseilles, Ill. 2200 w. Engng Rec—May 21, 1910. No. 14152.

Supports for Transmission Lines. C. T. Wilkinson. Illustrated discussion of some mechanical aspects of flexible tower construction. 2000 w. Elec Wld—May 19, 1910. No. 14164.

Protective Devices.

The Protection of High-Tension Alter-

We supply copies of these articles. See page 647.

nating-Current Machinery and Cables. Illustrates and describes the more modern methods adopted to ensure a reliable supply of electrical energy. 2000 w. Mech Wld—May 6, 1910. Serial. 1st part. No. 13972 A.

Resonance.

Resonance in Alternating Current-Circuits. J. Dalemont. Explains the term and where the phenomena is likely to be met, and its effects. Diagrams. 2000 w. Can Soc of Civ Engrs—1910. No. 14300 N.

Transformers.

Observation of Harmonics in Current and in Voltage Wave Shapes of Transformers. John J. Frank. An illustrated report of a series of tests and investigations with the oscillograph. 7000 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14347 F.

Transformer Currents in Weakened Deltas. Nicholas Stahl. Considers arrangements for stated cases. Diagrams. 1500 w. Elec Wld—May 26, 1910. No. 14392.

Magnetic Leakage in Transformers. E. G. Reed. Considers its effect on their regulation under normal and special conditions. Ills. 3500 w. Elec Jour—May, 1910. No. 14290.

Notes on the Design of Autotransformers. A. H. Avery. Notes on their design and manufacture, from the viewpoint of works' costs. 1200 w. Prac Engr—May 6, 1910. No. 13968 A.

Transformers for Metallic Filament Lamps. Information concerning types of transformers that may be employed, their efficiency and cost. 2000 w. Engr, Lond—April 22, 1910. No. 13734 A.

Wires.

Bare Aluminium Conductors. Illustrates and describes methods recommended for jointing and connecting. 1400 w. Engr, Lond—May 13, 1910. No. 14255 A.

MISCELLANY.

Electric Clocks.

Electric Clocks (Notes sur l'Horlogerie électrique). Léopold Reverchon. Describes types of direct-acting electromagnetic clocks. Ills. 1500 w. L'Elecn—April 9, 1910. No. 14018 D.

Insulating Materials.

Disruptive Strength with Transient Voltages. Joseph L. R. Hayden and Charles P. Steinmetz. An investigation, giving some results found with air and with dry white paraffine oil. Ills. 5000 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14348 F.

Japan.

Electricity in Japan. Shiro Sano. Brief review of development and progress. 1000 w. Sib Jour of Engng—May, 1910. No. 14318 C.

Rubber.

The Present Situation in Rubber. Gustave Heinsohn. A study of the relations between production and consumption. 3000 w. Cassier's Mag—May, 1910. No. 13945 B.

INDUSTRIAL ECONOMY.

Cost Systems.

Foundry Cost Systems (Zur Frage der Selbstkostenberechnung und Klassierung von Gussstücken). Engelbert Leber. Discusses methods of determining the cost of castings. Ills. Serial. 1st part. 2600 w. Stahl u Eisen—April 6, 1910. No. 14051 D.

Education.

Limitations of Efficiency in Engineering Education. George Fillmore Swain. Address at Union University, Schenectady, N. Y., at the opening of a new engineering building. An able discussion of engineering education. 9000 w. Eng News—May 12, 1910. No. 13890.

The Preliminary Training of Engineers. R. H. Smith. Brief discussion of what to teach? Whom to teach? and who should teach? 3000 w. Engr, Lond—April 22, 1910. No. 13731 A.

Engineering Shop Practice; Its Relation to Manual Training. Fred Duane Crawshaw. Analyzes the present situation in manual training schools and outlines shop courses of an engineering as well as mechanical character. 4500 w. Technograph, No. 24—1909-10. No. 14371 N.

Engineering Education in France and Abroad (La Formation des Ingénieurs en France et à l'Etranger). André Pelletan. A critical review of methods of technical education. 8500 w. Rev Gen d Sci—April 15, 1910. No. 14011 D.

The German Administrative Engineer (L'Ingénieur administratif Allemand). Maurice Bellom. Discusses provisions in Germany for educating engineers to fill administrative positions. 2000 w. Tech Mod—April 1910. No. 14016 D.

Schools of Marine Engineering and Navigation, in Continental Europe. W. H. Dooley. An account of the work in Holland, Prussia and Germany. 2500 w. Int Marine Engng—April, 1910. No. 12814 C.

Engineering.

The Valuation and Remuneration of Technical Knowledge (Die Wertung der technischen Intelligenz und die Verwer-

We supply copies of these articles. See page 647.

tung des technischen Könnens). W. Franz. A discussion of engineering as a profession. 5500 w. Tech u Wirt—April, 1910. No. 14245 D.

Engineering Societies.

The Institute of Operating Engineers. Editorial discussion of a proposed new organization. 2000 w. Power—May 24, 1910. No. 14267.

Exhibitions.

The Brussels Exhibition. First of a series of articles describing briefly the exhibits and their arrangement. 2000 w. Engr, Lond—May 13, 1910. Serial. 1st part. No. 14252 A.

The Brussels Exhibition, 1910 (Weltausstellung Brüssel 1910). Begins a general review of the project. Ills. Serial. 1st part. 2000 w. Elektrotech Rundschau—April 7, 1910. No. 14220 D.

Inventions.

The Development of Inventions. Arthur Pestel. A systematic study of the different methods. 2500 w. Cassier's Mag—May, 1910. No. 13953 B.

Labor Insurance.

The Pension and Insurance Law of April 5, 1910 (La Loi du 5 Avril 1910 sur les Retraites ouvrières et paysannes). Maurice Bellom. A review of recent labor legislation in France. 4500 w. Génie Civil—April 23, 1910. No. 14031 D.

Management.

Modern Methods of Shop Management. Frederick A. Waldron. Read before the Nat. Metal Trds. Assn. A discussion of factory management to meet modern conditions. 2500 w. Ir Trd Rev, May 5, 1910. Serial. 1st part. No. 13765.

The Twelve Principles of Efficiency and the Organization that Makes Their Application Possible. Harrington Emerson. First of a series of articles showing the successful working of these principles in historic examples. 4000 w. Engineering Magazine—June, 1910. No. 14376 B.

Time Keeping and Labour Distribution in the Foundry. Victor R. Claydon. This second article of a series considers the handling of stores and prevention of waste. 2500 w. Engineering Magazine—June, 1910. No. 14383 B.

How the Foreman Can Promote Shop Efficiency. Articles by William G. Reyer, George H. Roberts, and J. S. Sheafe discussing this subject. 5000 w. Ry Age Gaz—May 6, 1910. No. 13812.

The Organization of Industrial Works: A German Engineering View of the Question. Gives the substance of two articles by Herr Benno Orenstein, published in the *Frankfurter Zeit.* 4000 w. Ir & Coal Trds Rev—April 29, 1910. No. 13896 A.

Patents.

A Discussion of Leopoldo Salazar's Paper on the McArthur-Forest Cyanide Patents in Mexico; and the Lessons to be Learnt from the History of this Subject. John Malcolm Nicol. 3000 w. Can Min Jour—May 1, 1910. No. 13686.

Storeskeeping.

Railway Storekeepers' Association Gives abstracts of some of the papers presented. 9000 w. Ry Age Gaz—May 20, 1910. No. 14141.

Wage Systems.

Compensation of Workmen and Efficiency of Operation. H. L. Gantt. Fifth and concluding article of this series studying work, wages and profits. 3500 w. Engineering Magazine—June 1910. No. 14377 B.

The Compensation of Workmen. H. L. Gantt. Read before the Nat. Metal Trds. Assn. Suggestions for the training of workmen and paying for efficiency. 1500 w. Ry Age Gaz—May 6, 1910. No. 13815.

Premium Systems. Carl G. Barth. From an address before the Nat. Metal Trds Assn. A general discussion of their application to machine shops. Ills. 2000 w. Ir Age—May 5, 1910. No. 13747.

The Cost of Work. G. W. Dickie. From a paper read before the Tech. Soc. of the Pacific Coast. Discusses the "bonus system" and the limits of its application, and suggests a system to meet conditions on the Pacific Coast. 3000 w. Mech Wld—May 13, 1910. No. 14103 A.

Wage Payment Systems. John Anderson. Discusses how to secure maximum efficiency of labor. 2200 w. Ir Age—May 19, 1910. No. 14110.

MARINE AND NAVAL ENGINEERING.

Battleships.

The Fighting Power of Battleships. Archibald S. Hurd. An illustrated review showing the changes in naval artillery and describing modern gun-power development. 3500 w. Cassier's Mag—May, 1910. No. 13946 B.

The United States Battleship Florida. Illustrations of the launching of the newest and largest vessel in the U. S. Navy. Engineering Magazine—June, 1910. No. 14381 B.

Launch of the "Florida." Illustration and brief description of the second of the two largest battleships yet built in the United States. 1200 w. Sci Am—May 7, 1910. No. 13783.

His Majesty's Battleship "Hercules." Details of Launching-Ways. Illustrated

We supply copies of these articles. See page 647.

description of a vessel of the Dreadnought class. 1200 w. Engng—May 13, 1910. No. 14194 A.

Cruisers.

Comparative Trials of Scout Cruisers.—Birmingham—Salem—Chester. Report of the Board appointed by the Navy Department, explaining the object and describing tests. 26000 w. U. S. Navy Dept—Dec. 22, 1909. No. 14355 N.

The German Cruiser Von der Tann. Illustration, with brief description. 700 w. Engr, Lond—May 13, 1910. No. 14254 A.

Dredges.

Gold Dredgers. Illustrates and describes types built in England. 1500 w. Int Marine Engng—May, 1910. No. 13751 C.

15-Yard Dipper Dredge. Explains the advantages of the dipper dredge, and gives illustrated description of the "Toledo," built for work in Boston harbor. 2500 w. Int Marine Engng—May, 1910. No. 13750 C.

New Bucket Dredgers for the Kaiser Wilhelm Canal. Illustrated description of the largest type of bucket dredgers afloat. 2500 w. Int Marine Engng—May, 1910. No. 13753 C.

The Bucket and Pump Dredger Braila. Illustrated description of a dredger for use on the Danube River. 1200 w. Int Marine Engng—May, 1910. No. 13752 C.

An Electrically-Operated Suction Dredger. William T. Donnelly. Illustrated description of a new type. 1200 w. Int Marine Engng—May, 1910. No. 13754 C.

Mammoth Clay Cutting Suction Reclamation Dredgers. Illustrated description of dredgers built for India. 1200 w. Int Marine Engng—May, 1910. No. 13755 C.

Ferryboats.

The Ferryboats "Villa" and "Reggio" of the Italian State Railways (I Ferry-boats "Villa" e "Reggio" delle Ferrovie Italiane dello Stato). Describes vessels for service across the Strait of Messina. Ills. 1500 w. Ing Ferro—April 16, 1910. No. 14044 D.

Fishing Steamers.

German Types of Fishing Steamers (Die deutschen Fischdampfertypen). P. Knipping. A brief review of various types. Ills. 3500 w. Schiffbau—April 13, 1910. No. 14083 D.

Gun Foundations.

The Calculation of Gun Foundations (Berechnung als Grundlage der Konstruktion von Geschützunterbauten). Herr Pietzker. An extended mathematical discussion. Ills. Serial. 1st part. 4500 w. Schiffbau—April 27, 1910. No. 14084 D.

Houseboats.

How to Build a Houseboat for $300. Frederick K. Lord. Plans and directions for the construction of a comfortable boat that will house four or five people. 2000 w. Sci Am—May 14, 1910. No. 13887.

Ice Breakers.

See St. Lawrence River, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Motor Boats.

The Second International Motor Boat and Motor Exhibition in Berlin, 1910 (Die H. Internationale Motorboot- und Motoren- Ausstellung Berlin 1910). Herr Laudahn. A brief review of the exhibits. Serial. 1st part. 4000 w. Schiffbau—April 13, 1910. No. 14082 D.

Conversion of a Steamer on Zurich Lake to Diesel-Motor Power (Umbau eines Personendampfbootes auf dem Zurichsee für Dieselmotorenbetrieb). Describes the reconstruction and the new equipment. Ills. 1500 w. Zeitschr d Ver Deutscher Ing—April 2, 1910. No. 14234 D.

Propellers.

A Discussion of the Propeller Problem (Zur Lösung der Propellerfrage). Herr Rothe. An examination of recent contributions to propeller literature. Ills. 4200 w. Die Turbine—April 5, 1910. No. 14089 D.

Salving.

Salving a Stern-Wheeler. R. M. Reynolds. Describes the salving of the "Sultan," on the Niger River in Africa. 2000 w. Marine Rev—May, 1910. No. 14105.

Shipbuilding.

Recent Developments in Shipbuilding. Benjamin Taylor. A review of merchant shipbuilding during the past year. 6500 w. Cassiers Mag—May, 1910. No. 13952 B.

The Forges et Chantiers de la Méditerranée. Illustrated description of the Le Seyne shipbuilding yard of this company, and its equipment and work. 5000 w. Engng—April 22, 1910. Serial. 1st part. No. 13727 A.

Shipbuilding in 1909 (Scheepsbouw in 1909). J. H. Beucker Andreæ. Has particular reference to the industry in the Netherlands. 11000 w. De Ingenieur—April 9, 1910. No. 14249 D.

Ship Design.

The Most Advantageous Location of Bulkheads for Ships Designed for Light Homogeneous Cargoes (Die rechnerische Ermittelung der günstigsten Schottlage für Dampfer mit leichter homogener Ladung). H. Herner. A mathematical method of determination is given. Ills. 3000 w. Schiffbau—April 13, 1910. No. 14081 D.

Steamboats.

The Most Economical Type of Boat for Operation on Western Rivers with an 8-Ft. Channel Depth. John M. Sweeney. The stern paddle wheel is considered the type best adapted to the western rivers of the United States. Reviews early designs and developments. Also editorial. Ills. 8500 w. Eng News—May 5, 1910. No. 13774.

We supply copies of these articles. See page 647.

Steam Engines.

See Superheating, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steamships.

European Ore Carrying Steamships. Illustrated description of a vessel built for iron ore transport. 1700 w. Marine Rev—May, 1910. No. 14103.

Steam Turbines.

The Design of Manoeuvring Gear for Marine Steam Turbines. Diagrams and descriptions representing the principles of the systems fitted for the different arrangements of turbine machinery now generally adopted in marine practice. 1700 w. Engr, Lond—May 13, 1910. No. 14250 A.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Agricultural.

See Tractors, under AUTOMOBILES.

Axles.

Arched versus Straight Axles. R. W. Harvey Bailey. Investigates claims made for arched axles and concludes the only gain is in appearance. 1200 w. Autocar—April 23, 1910. No. 13706 A.

Carbureters.

Making Fuel Economy Tests. Albert L. Clough. Describes tests to determine whether better fuel economy is secured by the installation of a new carbureter. 2500 w. Horseless Age—May 18, 1910. No. 14136.

Cartercar.

Cartercar. Illustrated description of this friction-driven car. 2000 w. Automobile—May 19, 1910. No. 14131.

Commercial Vehicles.

Motor Vehicles Applied to Railroad Service. T. V. Buckwalter. Excerpt from paper read before the Engng Club of Altoona, Pa. Presents the advantages obtained by the Penn. R. R. by the use of these vehicles. 1500 w. Com Veh—May, 1910. Serial. 1st part. No. 13660 C.

Motor Vehicles for Newspaper Delivery. Arthur E. A. M. Turner. Information concerning the delivery service in London, the types employed and cost of operation. Ills. 1200 w. Com Veh—May, 1910. No. 13659 C.

Prussian Regulations Governing the Use of Motor Trucks on Highways (Motorlastwagen und Schutzvorschriften für Chausseen in Preussen). Gives the text of regulations designed to preserve the roads. 6000 w. Zeitschr d Mit Motorwagen Ver—April 15, 1910. No. 14097 D.

See also Competitions, under AUTOMOBILES.

Competitions.

The French Commercial Vehicle Competition in 1909 (Der französische Nutzwagen-Wettbewerb im Jahre 1909). Reports the results of the tests in a series of tables. 4000 w. Zeitschr d Mit Motorwagen Ver—April 15 1910. No. 14098 D.

Darracq.

The Latest Darracq Production. An illustrated article dealing with the main frame of single-piece construction, transmission gear details, and novel points connected with the engine. 1500 w. Auto Jour—May 14, 1910. No. 14181 A.

Electric.

Design for a Garage Charging Board. R. V. Sutliffe. Brief illustrated description of a suitable battery charging board and detailed directions for its use. 2000 w. Horseless Age—May 11, 1910. No. 13923.

Garages.

Heating, Ventilating and Mechanical Equipment of a Garage. Charles L. Hubbard. An explanation of the requirements and equipment of the complete garage. Ills. 9500 w. Horseless Age—May 4, 1910. No. 13824.

Municipal Garage Regulations. Gives ordinances of various cities aiming to reduce the fire risk. 3000 w. Horseless Age—May 4, 1910. No. 13831.

White Company's Garage in New York City. Brief illustrated description. 1200 w. Horseless Age—May 4, 1910. No. 13825.

Babcock Electric Vehicle Garage, Cleveland, Ohio. Describes building, storage room, charging plant, and features of service. Ills. 1800 w. Horseless Age—May 4, 1910. No. 13826.

Cincinnati Garages. Illustrated descriptions of the garages of the different companies in various parts of the city. 2500 w. Horseless Age—May 4, 1910. No. 13827.

Elmwood Garage, Providence, R. I. Illustrated description. 2500 w. Horseless Age—May 4, 1910. No. 13828.

Garage of Pacific Motor Car and Aviation Company, Los Angeles. Illustrated description of a large establishment in Southern California. 2000 w. Horseless Age—May 4, 1910. No. 13829.

Garage Business in Grand Rapids, Mich. Brief descriptions of the garages now available. Ills. 2000 w. Horseless Age—May 4, 1910. No. 13830.

We supply copies of these articles. See page 647.

Ignition.

The Magneto—Why It Makes Sparks. Herbert L. Towle. Explains the behavior of a magneto. Ills. 1500 w. Automobile—May 5, 1910. Serial. 1st part. No. 13771.

Lancia.

The 24 h. p. Four-Cylinder Lancia. Illustrated detailed description of a car having an excellent lubrication system and many features of interest. 1500 w. Autocar—April 23, 1910. No. 13707 A.

Military.

The Use of Motors for the Transport of Troops. T. Clarkson. A report of experiments with double-deck cars, followed by general discussion. 10000 w. Jour Roy U S Inst—April, 1910. No. 14280 N.

An Automobile Carrying an Electric Searchlight for the French Army (Projecteur électrique automobile de l'Armée française). Ch. Dantin. Illustrated description of the car and its equipment. 2500 w. Génie Civil—April 16. 1910. No. 14029 D.

Motor Power.

The Effect of Speed and Load on Power and Fuel Consumption. A study of the characteristics of petrol engines in regard to power, speed and fuel consumption. 2000 w. Auto Jour—April 23, 1910. No. 13705 A.

Motors.

One-Crank Radial Cylinder Engines. Archibald Sharp. Discusses the question of balance. Ills. 1800 w. Autocar—May 14, 1910. No. 14180 A.

Motor Tests.

Characteristic Curves of Petrol Engines. Brief description of a test on a petrol motor wagon weighing little over three tons. 600 w. Engr, Lond—May 6, 1910. No. 13979 A.

Noises.

Unnecessary Noises in Motor Car Operation. Albert L. Clough. Suggestions for preventing them. 1500 w. Horseless Age—May 11, 1910. No. 13922.

Omnibuses.

The Renewal of the Concession to the Omnibuses and Municipal Tramways in Paris (Le Renouvellement de la Concession des Omnibus et des Tramways municipaux, à Paris). A. Le Vergnier. A discussion of the importance of motor omnibuses in the transportation facilities of Paris. Ills. 3500 w. Génie Civil—April 2, 1910. No. 14024 D.

Packard.

Packard Nineteen Hundred and Eleven. Illustrated descriptions of new models. 3000 w. Automobile—May 19, 1910. No. 14130.

Peugeot.

A Twin-Cylinder "Lion" Peugeot Car. Illustrated description of this 12 h. p. model. 700 w. Auto Jour—April 30, 1910. No. 13839 A.

Shops.

See same title, under MACHINE WORKS AND FOUNDRIES.

Sizaire.

The Four-Cylinder Sizaire. Illustrated description of the chassis of this new car. 1100 w. Auto Jour—April 23, 1910. No. 13704 A.

Sleighs.

Two Novel Motor Sleds. Walter Langford. Illustrates an application of the pedrail system being constructed for Capt. Scott to use in his dash to the South Pole. Also gives illustrated description of a very different design successfully used in Sweden. 1200 w. Sci Am—May 14, 1910. No. 13884.

Steering Gears.

Laying Out Steering Gears for Automobiles. John L. Barra. A theoretical investigation. 1400 w. Mach, N Y—May, 1910. No. 13646 C.

Tractors.

Steam Ploughing Engine and Tractor at the Brussels Exhibition. Brief illustrated descriptions. 500 w. Engng—May 6, 1910. No. 13978 A.

Transmissions.

The Silent Chain. F. E. Watts. Describes the construction and use of chains of this type. Ills. 2000 w. Horseless Age—May 18, 1910. No. 14135.

Eccentric-Crank Mechanism in Automobiles (Untersuchung des Einflusses der Desachsierung bei Automobilmotoren). Walther Freiherr v. Doblhoff. An exhaustive mathematical discussion of this type of transmission. Ills. Serial. 1st part. 2000 w. Motorwagen—April 30, 1910. No. 14200 D.

White.

White Steam and Gasoline Cars for 1911. Illustrates and describes new models. 2500 w. Horseless Age—May 11, 1910. No. 13024.

COMBUSTION MOTORS.

Aeronautic Motors.

Recent Progress in Motors for Aeroplanes. W. F. Bradley. Illustrates and describes recent high-power, light-weight motors for flying machines. 2500 w. Cassier's Mag—May, 1910. No. 13950 B.

Fuels.

Fuel Quality and Engine Output. Cecil P. Poole. Shows that the power of a gas engine does not vary greatly with the quality of the fuel. Diagrams. 2000 w. Power—May 10, 1910. No. 13823.

Gas-Engine Cylinders.

Gas and Oil Engine Combustion Spaces. James W. Naylor. Gives a brief survey of the conditions to be observed, and a simple method of determining the volume of combustion spaces for gas and

oil engines. 1600 w. Engr, Lond—May 13, 1910. No. 14258 A.

Gas Engines.

The Development of the Gas Engine. E. T. Adams. Illustrated descriptions of typical American designs, with information relating to them. 5000 w. Pro W Ry Club—Feb. 15, 1910. No. 14275 C.

Horizontal vs. Vertical Gas Engines. John S. Leese. Compares the main features of the two types. 1200 w. Power—May 17, 1910. No. 13943.

Four-Cylinder High-Speed Gas Engine. Illustrated detailed description of a multi-cylinder, high-speed vertical type. 1200 w. Engr, Lond—April 29, 1910. No. 13864 A.

Gas Engine Using Blast-Furnace Gas at the Barrow Steel Works. Illustrations of three double-acting large gas-engines, with description and information. 1500 w. Engng—April 29, 1910. No. 13853 A.

Gas Power Plants.

The Status of Producer-Gas Power Plants in the United States. Editorial review of Prof. Fernald's report. 1800 w. Eng News—May 5, 1910. No. 13778.

Gas Turbines.

The Inherent Difficulty of the Gas Turbine. R. C. H. Heck. Explains why the gas turbine and the gas engine with combustion at constant pressure have been slow of successful realization. 2000 w. Power—May 3, 1910. No. 13671.

Oil Engines.

The Diesel Oil Engine for Land Work. Peter Stobie. Read before the Greenock Assn. of Engrs. & Shipbldrs. Compares the cycle of the Diesel engine with the Otto cycle and other internal-combustion engines, discussing the advantages. 4000 w. Mech Engr—May 13, 1910. No. 14191 A.

See also Gas-Engine Cylinders; under COMBUSTION MOTORS; and Motor Boats, under MARINE AND NAVAL ENGINEERING.

Pressures.

Mean Pressures in Internal-Combustion Engines. Explains why it is not wise to use extremely high pressures, and describes systems found to be economical. 1500 w. Mech Wld—April 22, 1910. No. 13724 A.

HEATING AND COOLING.

Air Humidifying.

Humidifiers, Their Principles and Useful Applications. Sterling H. Bunnell. An illustrated survey of types and their operation. 4000 w. Engineering Magazine—June, 1910. No. 14382 B.

See also Ventilation, under HEATING AND COOLING.

Central Plants.

Central Power and Heating Plant for a Group of School Buildings. Illustrated description of a plant at Brookline, Mass., for heating a manual training school, bath house, municipal gymnasium and high school. 2500 w. Heat & Vent Mag—May, 1910. No. 14305.

See also Power Plants, under POWER AND TRANSMISSION.

Liquid Oxygen.

Commercial Oxygen. Ernest A. Le Sueur. Describes the methods of production, giving a review of early processes. Ills. 3000 w. Met & Chem Engng—May, 1910. No. 13689 C.

Plant Testing.

Investigating a Heating Plant. Charles L. Hubbard. Shows how to make an examination of a proposed plant, or of one in use, how to collect data and deduce practical information. 2000 w. Met Work—May 21, 1910. No. 14142.

Refrigeration.

Artificial Systems of Refrigeration. C. P. Wood. Considers the refrigerants available, especially anhydrous ammonia and carbon dioxide. Also reviews briefly ammonia absorption and compression systems. 3500 w. Power—May 3, 1910. No. 13672.

Steam Heating.

How to Heat a Concrete House. Daniel R. Bacon. Describes how to install a complete steam heating plant, designed to be as inexpensive as possible and give the best results. Ills. 4000 w. Cement Age—May, 1910. No. 14303 C.

Ventilation.

Ventilation and Humidifying in Cotton Mills. W. H. Booth. Explains the need of heat and moisture in cotton spinning, and systems for securing the right conditions. 2000 w. Elec Rev, Lond—April 29, 1910. No. 13842 A.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Water-Driven Centrifugal. Brief illustrated description of exhibits shown at the Brussels International Exhibition. 700 w. Engng—April 22, 1910. No. 13728 A.

Centrifugal Pumps. William R. Wiley. Considers the scope and application of the pump to engineering problems, outlining features of modern practice. General discussion. Ills. 9500 w. Jour W Soc of Engrs—April, 1910. No. 14328 D.

The Theory of Centrifugal Pumps (Zur Theorie der Zentrifugalpumpen). J. Bartl. Mathematical. Ills. Serial. 1st part. 4500 w. Die Turbine—April 20, 1910. No. 14091 D.

Determination of the Velocity of Water in Centrifugal-Pump Piping (Determinacion de la Velocidad del Agua en las Tuberias de las Bombas centrifugas). Roberto Nicole. Mathematical. Ills. 3000 w. Energia Elec—April 25, 1910. No. 14045 D.

We supply copies of these articles. See page 647.

The Regulation of Centrifugal Pumps and Compressors (Ueber die Regulierung von Kreiselpumpen und -gebläsen). H. Hoffmann. A theoretical and practical discussion of regulating methods and devices. Ills. Serial. 1st part. 3500 w. Die Turbine—April 5, 1910. No. 14088 D.

See also Tailings Disposal, under MINING AND METALLURGY, ORE DRESSING AND CONCENTRATION.

Eddy Currents.

Eddy Currents as a Factor in Hydrodynamic Theory (Die Bedeutung des hydrodynamischen Wirbelbegriffes). R. Knoller. A discussion of the importance of this factor. 2000 w. Zeitschr f d Gesamte Turbinenwesen—April 30, 1910. No. 14096 D.

Pumping Plants.

Raising Water by Its Own Energy. Simpson Rice. Illustrates and describes the equipment of a pumping plant furnished with current from the main station. 3000 w. Power—May 24, 1910. No. 14262.

The Scoop-Wheel Pumping Plant at Schellingwoude, Holland. Charles S. Slichter. Information and illustrated description. 3000 w. Eng News—May 19, 1910. No. 14124.

Pumps.

The Humphrey Pump at the Brussels Exhibition. Illustrated description and report of tests demonstrating the economy of this gas pump. 800 w. Engr, Lond—May 13, 1910. No. 14257 A.

Turbine Design.

A Method of Calculating the Turning Moment of Turbine Machines (Di un Metodo di Calcolo per Determinare il Momento di Rotazione nei Turbo-motori e nei Turbo-operatori). Celeste Malavasi. Mathematical. Examines the cases of turbines and of centrifugal pumps and fans. Ills. 3500 w. Monit Tech—April 30, 1910. No. 14042 D.

Turbine Governing.

The Influence of the Piping on the Regulation of Water Turbines (Der Einfluss der Rohrleitung auf die Regulierung von Wasserturbinen). E. Braun. Mathematical. Ills. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—April 10, 1910. No. 14094 D.

Water Wheels.

Some Points in the Design of Impulse-Wheel Buckets. George M. Peek. A mathematical discussion of bucket design. Ills. 1500 w. Eng News—May 5, 1910. No. 13777.

MACHINE ELEMENTS AND DESIGN.

Axles.

Stresses in Axles under Variable and Shifting Load (Ueber die Spannungsverhältnisse in Achsen bei variabler und wandernder Belastung). W. Mader. Mathematical discussion of the stresses in the sheave axle of a mining hoist. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—April 22, 1910. No. 14207 D.

Ball Bearings.

See Shaft Bearings, under POWER AND TRANSMISSION.

Bolts.

See Rivets, under MACHINE ELEMENTS AND DESIGN.

Brakes.

The Design of Band Brakes (Systematische Untersuchung und Berechnung der Bandbremsen). H. Al. Siebeck. Mathematical investigation of the principles of their design. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—April 16, 1910. No. 14238 D.

Chains.

Proportions of Chain-Rings. I. Robson. Reports a series of tests on rings of various sizes to determine the safe limit of loading. Gives tabulated results. 1800 w. Engng—May 6, 1910. No. 13973 A.

Gears.

A Novel Reduction Gear. J. A. MacMurchy. Illustrated discussion of the Melville-MacAlpine reduction gear. 3000 w. Ap Sci—April, 1910. No. 14281 C.

Graphical Charts.

The Use of Stereographic Charts and Solid Models. John B. Peddle. Explains methods of laying out charts, and the making of various models. Ills. 3500 w. Am Mach—Vol. 33. No. 19. No. 13875.

Graphic Representation of Functions involving Three Variables (Représentation graphique des Fonctions à 3 Variables). L. Jannin. Describes a method of making graphical charts involving the geometry of three dimensions. Ills. 4500 w. Rev de Mécan—April, 1910. No. 14048 E + F.

Punch Frames.

The Strength of Punch and Riveter Frames Made of Cast Iron. A. Lewis Jenkins. Experimental investigations of the relation between the ultimate strength of curved cast-iron specimens and the ultimate strength of the attached test bars, comparing with results by various methods of analysis. Ills. 3500 w. Jour Am Soc. of Mech Engrs—May, 1910. No. 14330 F.

Rivets.

Designing Eccentrically Loaded Bolt and Rivet Groups. Harry Gwinner. Illustrates the stresses produced by an example, and gives data sheet supplement for facilitating the solution of such problems. 600 w. Mach, N Y—May, 1910. No. 13655 C.

Screws.

A Method of Finding Sizes of Roller Thread Screw Blanks. J. F. Springer. An approximate diameter formula is derived. 1200 w. Am Mach—Vol. 33. No. 21. No. 14389.

We supply copies of these articles. See page 617.

Stresses.

Strength of Materials Under Combined Stresses. Arthur Morley. Considers briefly whether it is time to discard established rules used in the design of parts subject to compound stress. 700 w. Engng—April 29, 1910. No. 13855 A.

Valves.

A New Water Pressure Regulating Valve with Electrical Quick-Opening Attachment. Illustrated description of the Anderson water pressure reducing valve with electrical quick-opening attachment. 600 w. Eng News—May 5, 1910. No. 13779.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

How to Use Chloride of Zinc in Melting Aluminum. Explains what it accomplishes as a flux. 700 w. Brass Wld—May, 1910. No. 14171.

See also Brass Founding, under MACHINE WORKS AND FOUNDRIES.

Annealing.

Annealing High Speed Steel in One Hour. C. U. Scott. Describes methods for greatly reducing the time of annealing. 1800 w. Am Mach—Vol. 33. No. 18. No. 13760.

Assembling.

Reorganizing a Run-Down Assembling Department. Alfred Spangenberg. Discusses fundamental principles applicable to all systems. 4500 w. Mach, N Y—May, 1910. No. 13648 C.

Boiler Making.

A Method of Handling Flue Work. C. E. Lester. Illustrates and describes a set of tools and gages, and a standard method of setting flues. 1000 w. Boiler Maker—May, 1910. No. 13920.

Boring Machines.

Vertical Boring and Turning Machine. Illustrated description of a machine shown at the Brussels Exhibition. 800 w. Engng—May 6, 1910. No. 13976 A.

Brass Founding.

The Chemist in the Brass Foundry. W. M. Corse. Explains the value of a chemist in brass foundry work. 1200 w. Met & Chem Engng—May, 1910. No. 13698 C.

Problems of the Brass Foundry. Considers economies effected by the use of molding machines in the production of brass and aluminum castings for automobiles. 1500 w. Foundry—May, 1910. No. 13667.

The Porosity of Brass Castings. C. Vickers. The cause and remedy. Ills. 1000 w. Foundry—May, 1910. No. 13666.

Case Hardening.

Some Recent Investigations on Case-Hardening. Sydney A. Grayson. Read before the I. and S. Inst. An investigation to determine the percentage of carbon diffused into the steel by the use of different compositions, and the effect produced at different temperatures. Ills. 3800 w. Ir & Coal Trds Rev—May 6, 1910. No. 13992 A.

Chain Making.

Automatic Machines Used in the Manufacture of Chain. Illustrates and describes novel devices. 1200 w. Am Mach—Vol. 33. No. 18. No. 13764.

Die Sinking.

Interesting Ways of Making Molds for Glassware Products. E. F. Lake. Die-sinking processes are illustrated and described. 1800 w. Am Mach—Vol. 33. No. 18. No. 13761.

Drilling Machines.

A New American Radial Drill. Illustrated description of a full universal triple-geared pattern. 2000 w. Ir Age—May 19, 1910. No. 14109.

Tests of Another Remarkable High-Speed Radial Drill. H. M. Norris. Illustrated description with tables and charts showing results obtained on various materials. 2000 w. Am Mach—Vol. 33. No. 20. No. 14115.

Enameling.

The Art of Enameling. Harold Holcroft. Read before the Soc. of Chem. Ind. Deals with vitreous enameling of cast iron for industrial purposes. 5000 w. Sci Am Sup—May 7, 1910. No. 13785.

Enameled Cast Iron Sanitary Ware. Dillen Underhill. Illustrated description of the design and construction of the enameling furnace, with a description of the sifter used for applying the enamel. 3000 w. Foundry—May, 1910. No. 13662.

Enamelling on Cast Iron (Ueber die gebräuchlichsten Emaillierverfahren auf Gusseisen). J. Schlemmer. A review of common practice. 1500 w. Giesserei-Zeit—April 15, 1910. No. 14065 D.

Etching.

The Manufacture of Etched Novelties. Illustrates and describes the making of etched brass buckles. 1500 w. Brass Wld—May, 1910. No. 14172.

Forging.

Forging in Old France. Joseph G. Horner. Illustrates and describes shop methods and early tools used in the eighteenth century. 1200 w. Mach, N Y—May, 1910. No. 13647 C.

Flow of Metals in Heading, Cold Forging and Swaging. H. P. Townsend. Illustrates and describes the action of materials handled under various pressures in dies. 4500 w. Am Mach—Vol. 33. No. 20. No. 14116.

Foundries.

The Sulzer Brothers' Foundry in Winterthur (Die Giesserei-Anlagen von Gebrüder Sulzer in Winterthur). Illustrated description of this large plant. Serial. 1st part. 2000 w. Giesserei-Zeit—April 1, 1910. No. 14063 D.

Foundry Coke.

The Chemistry of Coke and Iron Founding (Die Kokschemie unter besonderer Berücksichtigung der Eisengiesserei). Max Orthey. A review of the phenomena of combustion in the cupola, the effect of impurities in coke, etc. Serial. 1st part. 1500 w. Giesserei-Zeit—April 1, 1910. No. 14060 D.

Foundry Flasks.

A Simple Construction for Foundry Flasks handled by Crane (Ueber Kran-Formkasten und deren Herstellung nach vereinfachter Methode). H. Vetter. Illustrates and describes special types. 1600 w. Giesserei-Zeit—April 1, 1910. No. 14064 D.

Foundry Furnaces.

Crucible Steel Casting Process. Carl Smerling. Deals with the design and construction of furnaces for melting crucible steel. Ills. 1200 w. Foundry—May, 1910. Serial. 1st part. No. 13665.

Foundry Management.

See Management, under INDUSTRIAL ECONOMY.

Foundry Practice.

Latter-Day Steel Foundry Practice. Percy Longmuir. Read before the Manchester (Eng.) Assn. of Engrs. Discusses the crucible, open-hearth, side blow converter and electric processes. describes accurate methods for economical output. 1000 w. Am Mach—Vol. 33. No. 19. No. 13877.

erzeugung). J. Sonnenfeld. The first part discusses the acid open-hearth process. Serial. 1st part. 1500 w. Giesserei-Zeit—April 15, 1910. No. 14066 D.

Foundry Practice in Germany (Note sur l'Organisation de quelques Fonderies en Allemagne). M. Portevin. Discussion of features differing from French practice, particularly the treatment of molding sand, the use of molding machines, and the employment of testing laboratories. 1300 w. Rev de Métal—April, 1910. No. 14001 E + F.

Grinding.

Economy in Grinding. John J. Thacher. Illustrates and describes practices observed at the works of the Brown & Sharpe Mfg. Co. 2500 w. Mach, N Y—May, 1910. No. 13653 C.

The Vitrified Grinding Wheel and How It Is Made. Walter C. Gold. Descriptive account. 1200 w. Brass Wld—May, 1910. No. 14174.

Jarring Machines.

The Shockless Jarring Machine. Wilfred Lewis. Explains the principles upon which this labor-saving appliance works and its efficiency in the consumption of power. Ills. 4500 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14335 F.

Lacquering.

The Up-to-Date Method of Applying Lacquers. G. J. Nikolas. Illustrates and describes an apparatus for applying lacquer by means of the air brush or spray. 500 w. Brass Wld—May, 1910. No. 14173.

Lathes.

New Turn Table Lathe of Pratt & Whitney Company. Illustrated description of a lathe for machining bar stock, castings, and forgings. 3000 w. Am Mach—Vol. 33. No. 20. No. 14114.

Molding.

Molding Practice (Aus der Formereipraxis). H. Kloss. A practical discussion of hand molding. Ills. Serial. 1st part. 1200 w. Giesserei-Zeit—April 1, 1910. No. 14061 D.

Molding Cast Steel Drum Shells. H. J. McCaslin. Illustrates and describes a method of producing large steel sections, including a description of the spreading device, core boxes and pattern. 2200 w. Foundry—May, 1910. No. 13661.

Molding Bath Tubs (Formerei von Badenwannen). C. Irresberger. Describes practice in molding by hand and by machine. Ills. 2000 w. Stahl u Eisen—April 6, 1910. No. 14053 D.

Molding Machines.

New Farwell Molding Machines. Illustrated description of pneumatic roll-over machines and squeezers. 1000 w. Ir Age—May 5, 1910. No. 13749.

See also Brass Founding, under MACHINE WORKS AND FOUNDRIES.

Pipe Fittings.

Establishing a Commercial Standard for Pipe Fittings. F. W. Barrows. Detailed discussion of changes made to lessen cost. Ills. 5000 w. Mach, N Y—May, 1910. No. 13654 C.

Planers.

The Bateman Planer Drive. Joseph G. Horner. Illustrated description of a separate self-contained driving apparatus to be fitted to old designs of machines. 700 w. Mach, N Y—May, 1910. No. 13649 C.

A Regenerative Electric Drive for Planing-Machines. Illustrated description of driving arrangements, and explanation of considerations determining the choice of system to be adopted. 2000 w. Engng—May 6, 1910. No. 13975 A.

Reamers.

Irregular Spacing of the Cutting Edges of Reamers. Discusses the proper manner to break up the flutes of reamers. Diagrams. 800 w. Mach, N Y—May, 1910. No. 13656 C.

Shop Appliances.

Tools and Fixtures Used in Making Dentists' Appliances. F. A. Stanley. Illustrated description of small tools, jigs, fixtures, gages, etc. 2500 w. Am Mach—Vol. 33. No. 21. No. 14386.

We supply copies of these articles. See page 647.

Shop Design.

Metal-Working Plants and Their Machine-Tool Equipment. Charles Day. First of two articles analzing the machine-tool equipment of metal-working plants, especially as influencing the design, layout, and structural features of the buildings. Ills. 3000 w. Engineering Magazine—June, 1910. No. 14379 B.

The General Lay-Out and Equipment of a Complete Set of Engineering Shops for a Modern Colliery, with an Output of About 2000 Tons per Day. William Trimmer. Abstract of paper awarded first prize in the Lewis Prize Competition, 1909. Illustrated description. 3500 w. Ir & Coal Trds Rev—April 22, 1910. No. 13745 A.

Shop Management.

See Management, under INDUSTRIAL ECONOMY.

Shop Practice.

Mass Production in Small Establishments (Massenfabrikation in kleineren Betrieben). Martin H. Blancke. Shows the possibility of obtaining the economy of mass production in small shops. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—April 15, 1910. No. 14205 D.

Some Ingenious Economies of a Small Shop. T. A. Sperry. Illustrates and describes interesting devices and methods. 1500 w. Am Mach—Vol. 33. No. 18. No. 13762.

Machine Shop Practice. This first article of a series describes turning gas engine pistons in the turret lathe. Supplement. 300 w. Mach, N Y—April, 1910. Serial. 1st part. No. 13645 C.

Machining Vertical Engine Cylinder with Standard. Describes operations with the aim of showing the adaptability of the duplex horizontal boring machine. Ills. 1000 w. Prac Engr—April 29, 1910. No. 13848 A.

Machining a 21-Inch Sluice Valve Body and Plug. J. A. Gray. Illustrates and describes the method of performing the various operations in machining. 1500 w. Am Mach—Vol. 33. No. 21. No. 14388.

Some Machining Operations for Producing Motor Car Parts. Illustrates and 3000 w. Foundry—May, 1910. No. 13664.

Comparative Notes on Steel-Foundry Practice (Erfahrungen und vergleichende

Making the De Vilbiss Pliers. Ethan Viall. Gives in detail each step in the manufacture of pressed steel, cam motion, parallel-jaw pliers in a shop at Dundee, Mich. Ills. 2500 w. Mach, N Y—May, 1910. No. 13651 C.

Methods and Devices Used in Making Dental Vulcanizers. F. A. Stanley. Illustrates and describes interesting methods and devices. 2500 w. Am Mach—Vol. 33. No. 19. No. 13874.

Shops.

The Cincinnati Planer Company's New Plant. Illustrated detailed description of the shop and its equipment. 1200 w. Ir Age—May 26, 1910. No. 14384.

New Plant Where Selden Cars Are Built. Morris A. Hall. Illustrates and describes new factories at Rochester, N. Y., and their equipment for car building. 3000 w. Automobile—May 5, 1910. No. 13770.

Owen Automobile and Methods of Production Involved. Thomas J. Fay. Illustrates and describes the plant building this car, and the main features of the new model. 2500 w. Automobile—May 5, 1910. No. 13769.

Tempering.

See Tool Steels, under MATERIALS OF CONSTRUCTION.

Tools.

Examples of Box-Tool Design. F. P. Crosby. Illustrates and describes box-tools of different designs, with examples of the work for which each is intended. 1500 w. Mach, N Y—May, 1910. No. 13652 C.

Welding.

A Present Menace to Autogenous Welding. Editorial on the causes of accidents with this process. 1200 w. Ir Age—May 5, 1910. No. 13746.

The Manipulation of the Oxy-Acetylene Blowpipe. Herbert Luscius Whittemore. Detailed discussion of its use. Ills. 4500 w. Technograph, No. 24—1909-10. No. 14373 N.

Thermit Welding (Ueber das aluminothermische Verfahren). Al. Parma. Describes the process and gives an estimate of its possible uses in mining operations. Ills. 2500 w. Oest Zeitschr f Berg- u Hüttenwesen—April 30, 1910. No. 14071 D.

Wood-Working Machinery.

Railway Sleeper Adzing and Boring Machine. Illustrated description of a machine recently built for South American railway requirements. 500 w. Engr, Lond—May 6, 1910. No. 13984 A.

MATERIALS OF CONSTRUCTION.

Alloys.

The Manufacture of Britannia-Metal and Other Soft Metal Sheets; Their Uses and Adaptability. Illustrated description. 2500 w. Brass Wld—May, 1910. No. 14170.

A Recent Advance in the Alloy Industry (Une nouvelle Perspective dans l'Industrie des Alliages). K. Friedrich. Suggests a new method of fabricating alloys. 1400 w. Rev de Métal—April, 1910. No. 14006 E + F.

Alloy Steels.

Some Physical Properties of Two Per Cent Chromium Steels. Andrew McWilliam and Ernest J. Barnes. Read be-

We supply copies of these articles. See page 647.

fore the I. and S. Inst. A record of results of experimental work on the heat treatment of these steels. Ills. 4500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13990 A.

The Application of Titanium Alloys in the Steel Industry (Ueber Verwendung von Titan-Legierungen in der Stahlindustrie). Wilhelm Venator. Discusses the production and properties of titanium steel, giving results of tests. Ills. 2000 w. Stahl u Eisen—April 20, 1910. No. 14057 D.

Cast Iron.

The Chemistry of Cast Iron. Elmer E. Eakins. Read before the Phila. Found. Assn. Discusses heat treatment and the influence of chemical compounds upon the casting. 3000 w. Ir Age—May 12, 1910. No. 13871.

Physical Properties of Cast Iron. F. J. Cook. Read before the Staffordshire Iron & Steel Inst. Discusses the effect of sand, chills, casting temperature, rate of cooling, etc., upon the structure of gray iron. Ills. 3500 w. Foundry—May, 1910. No. 13663.

Heat Insulation.

An Investigation of Heat-Insulating Materials (Versuche mit Isoliermitteln). Reviews tests on various materials in Bavaria. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—April 16, 1910. No. 14239 D.

Metallography.

Uniform Nomenclature of Iron and Steel. John Oliver Arnold. Read before the I. and S. Inst. Discusses the present views of metallographists and urges the support of Prof. Le Chatelier in his effort to abolish personal names for the constituents of steel. 4500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13994 A.

The Homogeneity of Metals. Gregoire Tagueeff. Read before the I. and S. Inst. Considers the impotrance of studying the structure of metals, and the relation of the structure to the behavior in practice. Ills. 5000 w. Ir & Coal Trds Rev—May 6, 1910. No. 13991 A.

Further Observations on the Segregation of the Various Metalloids in Steel. S. S. Knight. Photomicrographs, and report of research work in the field of silicon-iron compounds. 1500 w. Ir Trd Rev—May 12, 1910. No. 13879.

The Crystallography of the Iron-Carbon System. Adolphe Kroll. Aims to establish generally the relation existing between crystallography and the stability diagram. Ills. 19500 w. Iron & Steel Inst—May, 1910. No. 13996 N.

The Constitution of Cast-Irons and Carbon Steels from the Practical Standpoint. Donald M. Levy. Read before the I .and S. Inst. Considers the relations existing between iron and carbon over practically the whole range of cast irons and carbon steels. 4000 w. Ir & Coal Trds Rev—May 6, 1910. No. 13987 A.

The Chemical and Mechanical Relations of Iron, Manganese, and Carbon. J. O. Arnold and A. A. Read. Read before the I. and S. Inst. An account of experimental investigations. Ills. 2500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13995 A.

The A2 Point in Chromium Steel. Harold Moore. Read before the I. and S. Inst. Gives results of an investigation upon a series of chromium steels in which a remarkable peculiarity was noted. 2800 w. Ir & Coal Trds Rev—May 6, 1910. No. 13988 A.

Steel.

The Elastic Breakdown of Certain Steels. C. A. M. Smith. (Abstract.) Read before the I. and S. Inst. Investigates methods of determining the maximum stress at elastic breakdown. Diagrams. 2500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13993 A.

Tin.

Physico-Chemical Researches on the Contagious Diseases of Metals (Recherches physico-chimiques sur les Maladies contagieuses des Métaux). Ernst Cohen. Discusses corrosion and other troubles in tin. Ills. 8500 w. Rev Gen d Sci—April 30, 1910. No. 14012 D.

A Physico-Chemical Study of Tin (Etudes physico-chimiques sur l'Etain). Ernst Cohen. Reports an investigation of the phenomena of hammer hardening. Ills. 5000 w. Rev de Métal—April, 1910. No. 14003 E + F.

Gray Tin (L'Etain gris). Ernst Cohen. An investigation of the corrosion of tin. Ills. 2000 w. Rev de Métal—April, 1910. No. 14004 E + F.

Tool Steels.

A Research on the Hardening of Carbon and Low-Tungsten Tool-Steels. Shipley N. Brayshaw. Deals with results obtained from two kinds of carbon tool-steel which differed only in that one contained about 0.5 per cent of tungsten. Considers questions connected with workshop hardening. Ills. 28800 w. Inst of Mech Engrs—April 15, 1910. No. 13726 N.

The Cutting Properties of Tool Steel. Edward G. Herbert. Read before the Ir. & St. Inst. Illustrated description of a tool-steel testing-machine designed to overcome difficulties in securing a uniform material, explaining its use and giving results. 2500 w. Engr, Lond—May 6, 1910. Serial. 1st part. No. 13985 A.

MEASUREMENT.

Cooling Curves.

Methods of Obtaining Cooling Curves. Deals with the various methods of taking cooling curves, and their interpretation and values. 3000 w. Engng—May 6, 1910. No. 13974 A.

We supply copies of these articles. See page 647.

Gauges.

Tolerances and Limit Gauges. George D. Hadun. Explains the meaning of "tolerance" in machine-shop practice, and the use of limit gauges. 2000 w. Mech Wld—May 13, 1910. No. 14192 A.

Accurate Gage Work in the Bench Lathe. A. L. Monrad. Illustrated description of a simplified method for exact duplication. 3000 w. Mach, N Y—May, 1910. No. 13650 C.

Pyrometry.

A New Pyrometer. Charles E. Foster. Describes a new type of radiation pyrometer and its use. 2200 w. Jour Fr Inst—May, 1910. No. 14295 D.

Steam Meters.

Steam and Air Flow Meters. Illustrates and describes recording and indicating instruments developed by the General Electric Co. 1500 w. Ir Age—May 26, 1910. No. 14385.

Thermometry.

High-Temperature Gas Thermometry and Its Present Limitations. Arthur L. Day. Reviews some of the recent work done to increase the range and accuracy of the temperature scale upon which the various devices for measuring high temperatures depend. 4000 w. Met & Chem Engng—May, 1910. No. 13605 C.

POWER AND TRANSMISSION.

Air Compressors.

Horizontal Compound Air Compressor. Illustrated detailed description. 1000 w. Engr, Lond—April 22, 1910. No. 13735 A.

Accidents to the Delivery Valve in Slide-Valve Compressors (Das Verhalten der Schieberkompressoren bei einer Beschädigung des Druckventils). R. Lorenz. Mathematical discussion of the thermodynamic effects, which have caused serious accidents. Ills. 3000 w. Glückauf—April 23, 1910. No. 14029 D.

Belting.

Transmission of Power by Belts. Reginald Krall. Abstract of a paper read before the Junior Inst. of Engrs. Discusses the use in Europe of steel bands for belts. Also describes the Lenix system in which an idler automatically increases the arc of contact of the belt with the load. 2200 w. Power—May 3, 1910. No. 13670.

CO_2 Engine.

Carroll's Carbonic Acid Engine. An exposé of John E. Carroll's CO_2 engine. Ills. 1500 w. Power—May 24, 1910. No. 14265.

Costs.

See Textile Mills, under POWER AND TRANSMISSION.

Electric Driving.

Motor Application to Machine Tools. Charles Fair. Considers the fundamental principles underlying motor applications to machine tools. Ills. 4000 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14345 F.

The Choice of Electric Motors for Intermittent Working (Ueber die Wahl von Elektromotoren für intermittierenden Betrieb). Herr von der Burchard. Discusses the choice of motors for rolling-mill operation. Ills. 2500 w. Stahl u Eisen—April 13, 1910. No. 14055 D.

The Electrical Driving of Textile Machinery. W. B. Woodhouse. An illustrated article giving comparative results with mechanical and electrical driving. 3500 w. Cassier's Mag—May, 1910. No. 13948 B.

Electric Driving of Reversible Roll Trains on the Ilgner System (Commande électrique des Trains de Laminoirs réversibles par la Méthode Ilgner). Describes the system and gives results of its operation. Ills. Serial. 1st part. Rev Indus—April 23, 1910. No. 14023 D.

See also Planers, under MACHINE WORKS AND FOUNDRIES.

Gas Transmission.

Long-Distance Gas Transmission. Harrison Dexter Emerson. Outlines the development and present state of the art of gas transmission, giving information in regard to high-pressure gas pumping in Pennsylvania. Ills. 1400 w. Cassier's Mag—May, 1910. No. 13947 B.

Gearing.

See Electric Hoisting, under MINING AND METALLURGY, MINING.

Lubrication.

Lubrication and Lubricants. Discussion of Dr. C. F. Mabery's paper, by Dr. P. H. Conradsen, and others. Ills. 12800 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14336 F.

Some Recent Lubricators (Quelques Graisseurs nouveaux). Describes recently invented oil-testing and lubricating devices. Ills. 5000 w. Rev de Mécan—April, 1910. No. 14049 E + F.

Mechanical Plants.

La Salle Hotel Power Plant, Chicago. Osborn Monnett. Illustrates and describes the mechanical plant for furnishing heat, light and power. 2500 w. Power—May 17, 1910. No. 13939.

Power Plants.

Government Plant at Washington. F. L. Johnson. Illustrated description of the central power, lighting and heating station, for the United States Capitol, serving a group of buildings. 2000 w. Power—May 10, 1910. No. 13818.

Shaft Bearings.

Ball-Bearing Lineshaft Hangers. Henry Hess. Illustrated description of improved hangers, explaining their advantages. 2000 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14333 F.

We supply copies of these articles. See page 647.

Shafting.

Effect of Keyways on the Strength of Shafting. James C. Lund. A report of tests, with conclusions. Ills. 1200 w. Technograph, No. 24—1909-10. No. 14372 N.

Textile Mills.

Choice of Power for Textile Mills. Abstract of a paper by Charles T. Main, discussing the cost of steam, hydroelectric, and purchased power for an electrically driven mill. 2000 w. Eng Rec—May 7, 1910. No. 13797.

Tidal Power.

Tidal Power. W. O. Horsnaill. Considers whether there is a possibility of generating power on a large scale by use of the tides. 2000 w. Engr, Lond—May 6, 1910. No. 13981 A.

Turbo-Compressors.

See Centrifugal Pumps, under HYDRAULIC MACHINERY.

STEAM ENGINEERING.

Boiler Capacity.

Increasing Capacity of Steam Boilers. Henry Kreisinger and Walter T. Ray. Investigates the practicability of doubling the grate area and increasing the velocity of the gases without increasing the floor space. 4000 w. Power—May 24, 1910. No. 14264.

The "Le Dalmar" Boiler Cleaner (Le Ramoneur à Air chaud "le Dalmar"). M. Brull. Describes a device for blowing incrustations of soot from the outside or inside of boiler tubes. Ills. 1400 w. Bul Soc d'Encour—March, 1910. No. 14007 G.

Boiler Design.

The Layout of an Arched Smoke Box. Drawings and description of method. 1800 w. Boiler Maker—May, 1910. No. 13921.

Boiler Firing.

Kermode's Liquid-Fuel Apparatus for Water-Tube Boilers. Illustrated description of an installation at Liverpool and an account of the arrangement. Other plants are briefly described. 2000 w. Engng—April 22, 1910. No. 13730 A.

Boiler Fittings.

Water Gauges for Boilers: Some Practical Notes. Points relating to their construction and care are discussed. 2000 w. Prac Engr—May 6, 1910. No. 13969 A.

Boiler Plates.

Tests of Old Boiler Plates. A. H. Eldredge. Reports tests made from test pieces cut from the bottom sheets of fire tube boilers which had been in continuous service for periods ranging from 13 to 22 years, to get information as to the safe age at which a boiler can be used. 1000 w. Sib Jour of Engng—May, 1910. No. 14317 C.

Boiler Repairs.

Applying Patches to Boilers. H. S. Jeffrey. Illustrates and describes the most approved methods. 1500 w. Power—May 24, 1910. No. 14263.

Boiler Scale.

Scale in Boilers and Its Removal. From an article published by the Fidelity & Casualty Co. Deals with causes and dangers of scale, and methods of prevention and removal. 3000 w. Power—May 17, 1910. No. 13941.

The Influence of Scale on Boiler Economy and Safety (Der Einfluss des Kesselsteines auf Wirtschaftlichkeit und Betriebsicherheit von Heizvorrichtungen). E. Reutlinger. Reports a series of tests of heat transmission through scale-covered plates. Ills. Serial. 1st part. 7500 w. Zeitschr d Ver Deutscher Ing—April 2, 1910. No. 14233 D.

Boiler Waters.

Water Softening. Illustrates and describes a number of systems of softening boiler feed water. 5000 w. Ry Mas Mech—May, 1910. No. 13872.

Engines.

Economy and Design of Modern Reversing Rolling Mill Steam Engines. Eduard G. Sehmer and Dr. R. Drawe. Read before the Ir. & St. Inst. States the requirements of a good steam reversing mill engine, and the means by which these requirements can be fulfilled. Describes a new single lever gear. 3300 w. Mech Engr—May 6, 1910. No. 13971 A.

Tangye's Museum of the Watt Epoch-Making Developments. I. W. Chubb. Illustrated description of interesting drawings, appliances and inventions. 4500 w. Am Mach—Vol. 33. No. 18. No. 13763.

Fuels.

The Combustion of Coal. Joseph A. Holmes. Describes experiments made to ascertain the relation between the amount of volatile combustible driven off and the combustion spaces necessary to burn it completely. Ills. 3000 w. Bul Am Inst of Min Engrs—May, 1910. No. 14344 F.

Thermochemistry of Anthracite. Discusses the principles underlying the calculation of heating values of fuels. 2500 w. Mines & Min—May, 1910. No. 13681 C.

Notes on Various Solid Fuels. Considers fuels, other than ordinary coal, in use. 1200 w. Prac Engr—April 22, 1910. Serial. 1st part. No. 13716 A.

Tests of Washed Grades of Illinois Coal. C. S. McGovney. Describes tests made to facilitate comparisons of various grades. Ills. 28600 w. Univ of Ill Bul, No. 39—Aug. 23, 1909. No. 14268 N.

Transportation and Handling of Steam Coal. Reviews a report of the committee on fuel supply of the Boston Chamber of Commerce. A study of the quality of steam coals and the method of transportation. Relates especially to New England. Maps. 3000 w. Ry Age Gaz—May 13, 1910. No. 13898.

We supply copies of these articles. See page 647.

The Utilization of Low-Grade Coal in the Dortmund District (Ausnutzung minderwertiger Brennstoffe auf Zechen des Oberbergamtsbezirks Dortmund). Herrn Bütow and Dobbelstein. Report of a Commission, giving results of tests of inferior grades of fuel in various boiler plants. Ills. Serial. 1st part. 2000 w. Glückauf—April 9, 1910. No. 14075 D.

Heat Transmission.

A Study in Heat Transmission. J. K. Clement and C. M. Garland. Experimental study of the transmission of heat to water in tubes as affected by the velocity of the water. 3500 w. Univ of Ill Bul, No. 40—Sept. 27, 1909. No. 14199 N.

Indicators.

Non-Stop Indicating Gear. Illustrated description of an apparatus which can be fixed to an engine while running, can be started, stopped or removed while the engine is in motion. 900 w. Engr, Lond—April 22, 1910. No. 13738 A.

Safety Valves.

Recent Developments in High-Lift Safety Valves (Neuerungen an Hochhub-Sicherheitsventilen mit vollem Kegelhub). P. H. Rosenkranz. Describes a number of types. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—April 9, 1910. No. 14235 D.

Stacks.

The Stability of Chimneys. E. W. Beardsley. Gives graphic methods for determining the center of area and stability, approximate rules for proportions and taper and notes on the design of chimney foundations. 2500 w. Power—May 3, 1910. No. 13669.

Steam Properties.

Equivalent Evaporation from and at 212°. F. R. Low. An extension of the Marks-Davis tables on factors of evaporation to include feed water above 212 degrees, and to include modern high pressures. 2 pages of tables. 1200 w. Power—May 10, 1910. No. 13820.

Superheating.

A New Characteristic Equation of Superheated Steam. P. F. Popp. An explanation of the new simplified equation. 900 w. Technograph. No. 24—1909-10. No. 14375 N.

Marine Superheating. Notes based on an inspection of the plant in the Schwann vessel. Ills. 1600 w. Engr, Lond—April 22, 1910. No. 13733 A.

Cast-Iron Fittings for Superheated Steam. Discussion of papers by Prof. Ira N. Hollis, Prof. Edward F. Miller and Arthur S. Mann. Ills. 10700 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14337 F.

Turbine Blades.

The Erosion of Turbine Blades. K. J. Ekblaw. Reports a series of tests upon two Kerr turbine blades to ascertain the wear increase with increase in velocity of steam. 1200 w. Technograph, No. 24—1909-10. No. 14369 N.

Turbine Design.

The Condition and Action of Steam in Turbines. Ernst J. Berg. Shows the practical considerations that enter into the design of the Curtis turbines. 4500 w. Technograph, No. 24—1909-10. No. 14368 N.

Turbine Economy.

Reducing the Fuel Consumption in Existing Electric Generating Stations. Gives calculations showing the possibilities of the low-pressure turbine in reducing the fuel bill. 1800 w. Engr, Lond—April 29, 1910. No. 13859 A.

Turbine Efficiency.

Energy Losses in Steam-Turbine Buckets. Abstract of an article by Dr. Nikolai Briling in *Zeit. des Ver. Deut Ing.*, describing a series of experiments made to determine the least loss of energy in the buckets of an impulse steam-turbine. Ills. 700 w. Engng—April 29, 1910. No. 13854 A.

Turbine Governing.

Regulation of Mixed Flow Turbines. L. Battu. Explains where mixed-flow turbines are necessary, and considers the methods of regulation. Ills. 3300 w. Power—May 10, 1910. No. 13819.

The Kinematics of Reversing with Indirect Governors (Zur Kinematik der Rückführung bei indirekten Regulatoren). Herr Kröner. Mathematical discussion of two systems of governing. Ills. 2500 w. Die Turbine—April 20, 1910. No. 14093 D.

Turbine Plants.

The Steam-Turbine Plant at the Gouley Mine in the Eschweil District (Die Dampfturbinenanlage auf Grube Gouley des Eschweiler Bergwerksvereins). L. Haas. Detailed description of a generating station serving a group of mines. Ills. Serial. 1st part. 1000 w. Zeitschr f d Gesamte Turbinenwesen—April 10, 1910. No. 14095 D.

The 1,650-Kilowatt Exhaust-Steam Turbo-Generator Plant of the "Fröhliche Morgensonne" Company at Wattenscheid (Die 1650-KW-Abdampfturbogeneratoranlage auf der Gewerkschaft "Fröhliche Morgensonne" zu Wattenscheid). Illustrated description. 3000 w. Elek Kraft u Bahnen—April 23, 1910. No. 14224 D.

Turbines.

The Gutehoffnungshütte Steam Turbine (Die Gutehoffnungshütte-Dampfturbine). Herr Banner. Describes its design, development and present types. Ills. Serial. 1st part. 2200 w. Die Turbine—April 20, 1910. No. 14092 D.

See also Locomotives, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

We supply copies of these articles. See page 647.

TRANSPORTING AND CONVEYING.

Cableways.

Aerial Ropeway at Abertillery, South Wales. Illustrated description of a ropeway built on the sectional system, for a colliery. 1200 w. Engng—April 22, 1910. No. 13729 A.

Coal Handling.

Darley Suction Conveyor for Coal and Ashes. Illustrates and describes the installation for the Boston elevated railway. 1000 w. Ir Age—May 12, 1910. No. 13869.

Coal and Coke Handling at the Moosach Gas Works, Munich (Die Kohlen- und Kokstransportanlage des Gaswerkes der Stadt München in Moosach). H. Hermanns. Describes an extensive mechanical plant. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—April 23, 1910. No. 14240 D.

See also Piers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Conveyors.

The Mechanical Handling of Small Materials. George Frederick Zimmer. Methods and mechanisms for handling fine substances are illustrated and described. 3000 w. Cassier's Mag—May, 1910. No. 13951 B.

Mechanical Transport in the Foundry (Der mechanische Massentransport in der Giesserei). Hubert Hermanns. Describes conveyors, aerial tramways, elevators, etc., applicable to foundry work. Ills. Serial. 1st part. 1500 w. Stahl u Eisen—April 6, 1910. No. 14052 D.

Cranes.

The Design of Crane Trusses (Zur Berechnung von Kranträgern). H. Müller. Mathematical. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—April 30, 1910. No. 14244 D.

Freight Handling.

Trans-shipment of Building Materials on the Berlin Waterways and the Application of Mechanical Devices to the Handling of Brick (Der Umschlagverkehr in Baumaterialien auf den Berliner Wasserstrassen und die zweckmässigkeit der Verwendung mechanischer Entladevorrichtungen für den Ziegeltransport). Carl Claus. Ills. 4000 w. Tech u Wirt—April, 1910. No. 14247 D.

Ore Handling.

The Sieurin Ore Discharging Gear. Illustrated description of the apparatus and its operation. 2000 w. Marine Rev—May, 1910. No. 14104.

MISCELLANY.

Aeronautics.

The Problem of Flight (Betrachtungen über das Flugproblem). L. Prandtl. A general discussion of aeroplane design. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—April 30, 1910. No. 14241 D.

A Graphical Method of Designing Aerial Propellers and Its Special Application to the Calculation of the Strength of the Propeller. Comparison of the Calculation with the Practical Result (Methode für die graphische Berechnung einer Luftschraube und ihre spezielle Verwendung für die Festigkeitsberechnung der Schraube. Vergleich der Rechnung mit der Wirklichkeit). C. Eberhardt. Mathematical. Ills. Serial. 1st part. 3000 w. Motorwagen—April 20, 1910. No. 14099 D.

Recent Progress in Aviation. Octave Chanute. An illustrated review of recent work with flying machines, and interesting information related to the subject. Also a chronology of aviation. 8000 w. Jour W Soc of Engrs—April, 1910. No. 14325 D.

The Flight from London to Manchester. The aviators' own accounts, with illustrations. 1200 w. Sci Am—May 14, 1910. No. 13885.

Trans-Oceanic Aviation. Editorial discussion of the plan recently proposed to cross the Atlantic in an airship. 1200 w. Engng—May 13, 1910. No. 14196 A.

Dirigibles and Aeroplanes in War (I Dirigibili ed i Velivoli come Ordegn di Guerra e come Bersagl). Discusses balloons and aeroplanes as instruments of attack and methods of defense against them. Ills. 10000 w. Riv Marit—April, 1910. No. 14035 E + F.

Table of Aeroplanes at Olympia. Gives table of particulars of each machine, with observations on the theories of flight. 4000 w. Sci Am Sup—May 7, 1910. No. 13786.

A Pioneer French Aeroplane That Has Made Many Flights. Augustus Post. Illustrated description of a monoplane type of good workmanship, which has an ingenious motor. 2500 w. Am Mach—Vol. 33. No. 20. No. 14117.

Guns.

Chats on Artillery (Causeries sur l'Artillerie). Colonel Vallier. The first part discusses guns for attacking balloons and aeroplanes. Ills. Serial. 1st part. 2300 w. Tech Mod—April, 1910. No. 14015 D.

Tabulating Machines.

Handling the Census Returns for the Whole United States. Illustrates and describes the machines which make and count the cards and tabulate the records. 2000 w. Am Mach—Vol. 33. No. 18. No. 13759.

Textile Industry.

The Mechanical Engineer and the Textile Industry. H. L. Gautt. Describes an automatic piling machine and a new arrangement of bleachery, in proof of the usefulness of the mechanical engineer in this field. Ills. 600 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14332 F.

We supply copies of these articles. See page 647.

MINING AND METALLURGY.

COAL AND COKE.

Blasting.

Utah Fuel Co.'s Shot-Firing Rules. A. C. Watts. Regulations for the storage and handling of explosives, loading holes and firing shots enforced by this company. 2400 w. Mines & Min—May, 1910. No. 13676 C.

The Hydraulic Mining Cartridge. Henry M. Payne. Illustrated description of an appliance for mining coal without the use of explosives. 1500 w. Mines & Min—May, 1910. No. 13674 C.

Colorado.

Coal Fields of Southern Colorado. Describes the geological conditions and their influence on the mining methods employed. 2000 w. Mines & Min—May, 1910. No. 13675 C.

See also Mining, under COAL AND COKE.

Electric Power.

Electricity in Mining. J. Glynn Williams. Discusses proper equipment, operation, some causes of accidents, etc. 3000 w. Elec Rev, Lond—April 22, 1910. No. 13709 A.

The Installation and Management of Electrical Plant in Coal Mines. T. Campbell Futers. Considers applications that may be made from the first step of opening a new coalfield, the questions to be decided in selecting plant, etc. 2500 w. Elec Rev, Lond—April 22, 1910. No. 13710 A.

Electric Cable Systems in Collieries. Editorial review of the discussion before the Institution of Electrical Engineers, following the reading of W. Wellesley Wood's paper dealing with this subject. 2800 w. Engng—May 13, 1910. No. 14195 A.

Automatic Protective Switchgear for Colliery Service. E. B. Wedmore. Abstract of paper read at Midland Inst. of Min., Civ. & Mech. Engrs. Discusses the arrangement of trip coils and the action of automatic leakage devices in mines. 1600 w. Elect'n, Lond—May 6, 1910. No. 13967 A.

Storage Batteries in Colliery Work. J. Glynn Williams. Discusses the economical advantages. Short discussion. 4500 w. Ir & Coal Trds Rev—May 6, 1910. No. 14101 A.

Earthed v. Insulated Neutrals in Colliery Installations. W. Wellesley Wood. Read before the Inst. of Elec. Engrs., Newcastle Sec. Discusses the advantages and disadvantages of working in a three-phase colliery installation with an earthed as against an unearthed neutral. 2500 w. Elec Engr, Lond—April 29, 1910. No. 13841 A.

See also Isolated Plants, and Switchgear, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Explosions.

Catastrophes in American Mines. Messrs. Taffanel and Dunaime. A resumé of the report of the French Committee of Mines on the Monongah, Darr and Naomi accidents. 4000 w. Mines & Min—May, 1910. No. 13677 C.

Darran Colliery Explosion. Report of the circumstances attending an explosion of coal dust in South Wales. 4000 w. Col Guard—April 22, 1910. No. 13725 A.

Gas Explosions in Belgium (Grubengasausbrüche in Belgien). Herr Bracht. A review of notable explosions and preventive methods employed. Ills. 9500 w. Glückauf—April 2, 1910. No. 14072 D.

Catalytic Action and Explosions of Gas (Katalytische Wirkungen und Schlagwetterexplosionen). Hans Fleissner. Offers an explanation of the causes of gas explosions. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—April 9, 1910. 14068 D.

Explosives.

Permissible Explosives Used in Coal Mines. J. J. Rutledge. Information concerning the permissible explosives used in the United States, and their advantages. 1500 w. Technograph, No. 24—1909-10. No. 14370 N.

Mine Air.

Moisture in Mine Air. Considers the hygienic and mechanical effects of moisture, how a mine dries out and methods of avoiding it. 4500 w. Mines & Min—May, 1910. No. 13673 C.

Mine Gas.

Firedamp; Its Composition, Detection and Estimation. Dr. Thomas Gray. Abstract of a paper read before the Min. Inst. of Scotland. Gives a summary of researches, and considers methods of testing for gas. 2000 w. Ir & Coal Trds Rev—April 22, 1910. No. 13744 A.

Mine Maps.

Mapping Methods in Pittsburg Field. J. H. Dickerson. Gives the scale used, the different colors, and the methods of indicating different objects and workings. 2000 w. Mines & Min—May, 1910. No. 13680 C.

Mine Shops.

See Shop Design, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Mining.

Report on Coal Mines Regulations Re-

We supply copies of these articles. See page 647.

lating to Submarine Coal Areas. T. E. Forster. Report submitted to the government of Nova Scotia. 2500 w. Can Min Jour—May 1, 1910. No. 13685.

A Suggestion to the Coal Mining Industry. T. B. Bancroft. Thinks if entries were driven first to the boundary and the retreating system used, there would be greater recovery and fewer fatalities. 3300 w. Eng & Min Jour—April 30, 1910. No. 13636.

Coal Mining at Primero, Colorado. R. L. Herrick. Describes different methods that have been adapted to fit the conditions. Plan. 1800 w. Mines & Min—May, 1910. No. 13678 C.

Mining by Successive Slices (Le Stossbau). L. Crussard. An exhaustive description of the diverse forms and applications of this method of mining. Serial. 1st part. 4500 w. Tech Mod—April, 1910. No. 14014 D.

Rescue Appliances.

Tissot Breathing Apparatus for Rescue Work. Henry Briggs. Describes the machine and gives instructions for its use. Ills. 2500 w. Eng & Min Jour—May 14, 1910. No. 13928.

Rescue Stations.

Rescue Station at Leiseuring No. 1. Charles B. Franks. Abstract of a paper read before the Coal Min. Inst. of America, at Pittsburg. Describes the general safety measures of the H. C. Frick Coke Co. 2000 w. Mines & Min—May, 1910. No. 13679 C.

Safety Lamps.

Lamp Cabin at the Tinsley Park Collieries. Plan and illustrated description of a cabin for safety lamps and their care. 1000 w. Ir & Coal Trds Rev—May 13, 1910. No. 14261 A.

Supplies.

The Known Coal Deposits of the Earth and the Time of Their Probable Exhaustion (Die bekannten Steinkohlenlager der Erde und der Zeitpunkt ihrer voraussichtlichen Erschöpfung). Fritz Frech. An exhaustive study, beginning with England and Germany. Serial. 1st part. 8000 w. Glückauf—April 30, 1910. No. 14080 D.

COPPER.

Alaska.

The Copper-Bearing Amygdaloids of the White River Region, Alaska. Adolph Knopf. Describes the geological features and modes of occurrence, discussing the origin. 3000 w. Ec-Geol—April, 1910. No. 14314 D.

British Columbia.

The True Fissure and Broadview Mines, B. C. Newton W. Emmens. Illustrated description of these mines of low-grade ore and the methods used. 2500 w. Min Wld—May 7, 1910. No. 13802.

Converters.

The Vortex Copper Converter. Herbert Haas. Discusses the consumption of air in converters, the arrangement of tuyeres, etc. 2200 w. Eng & Min Jour—May 7, 1910. No. 13795.

Oklahoma.

Copper in the "Red Beds" of Oklahoma. William Arthur Tarr. Notes on the occurrence of this deposit, of probably Permian age. Contains also high values of gold and silver. Ills. 1500 w. Ec-Geol—April, 1910. No. 14312 D.

Portugal.

See Spain, under COPPER.

Review of 1909.

Copper Production and Price in 1909 and the Present Outlook. John B. C. Kershaw. A study of the statistics for 1909. 1000 w. Elec Rev, Lond—May 13, 1910. No. 14183 A.

Smelting.

Recent Reverberatory Smelting Practice. Redick R. Moore. Notes on means of overcoming difficulties encountered, with suggestions for improvements. 4500 w. Eng & Min Jour—May 14, 1910. Serial. 1st part. No. 13926.

Reverbatory Treatment of Copper and Copper Mattes. H. Schroder. Describes the method adopted at the Great Cobar, Ltd., Lithgow Works (N. S. W.) 2000 w. Aust Min Stand—April 6, 1910. No. 13838 B.

Spain.

The Copper Mines of Southern Spain and Portugal. The present number describes the situation, general features and trade. Map. 1600 w. Min Jour—April 30, 1910. Serial. 1st part. No. 13851 A.

Utah.

Underground Mining Practice at Bingham, Utah. Leroy A. Palmer. Illustrated description of the methods at the various copper mines of this district. 7500 w. Min Wld—April 30, 1910. No. 13642.

GOLD AND SILVER.

Amalgamation.

Principles of Electrolytic Amalgamation. Elmer E. Carey. Discusses the underlying principles of amalgamation. 2000 w. Min Wld—April 30, 1910. No. 13644.

Recovery of Values in Dredge and Placer Tailings. Elmer Ellsworth Carey. Calls attention to the amount of gold lost in dredging and indicates a method of saving by the use of electro-chemical mercury riffles. 1500 w. Min Jour—April 23, 1910. No. 13717 A.

Bohemia.

The Mt. Roudny Gold Deposit. Joseph T. Singewald, Jr. Describes recent operations on a long abandoned gold occurrence in Bohemia. 2000 w. Ec-Geol—April, 1910. No. 14315 D.

Bolivia.

Gold Dredging Possibilities in Bolivia.

We supply copies of these articles. See page 617.

Alexander Benson. Brief account of rich unexplored fields in the interior, and the difficulties that must be overcome in their development. 1800 w. Min Wld—April 30, 1910. No. 13643.

Chlorination.

Chlorination Process at the Kennedy Mine, Cal. W. H. Storms. Describes the treatment of auriferous sulphides. 1600 w. Min Wld—May 7, 1910. No. 13804.

Cobalt.

The McKinley-Darragh-Savage Mines of Cobalt, Limited. Abstract of General Manager P. A. Robbins' report for the year 1909. 3500 w. Can Min Jour—May 15, 1910. Serial. 1st part. No. 14113.

Cyaniding.

Some Characteristics of Sands in Cyaniding. Herbert A. Megraw. Gives results of experiments with a particular kind of ore. 1500 w. Min Wld—May 7 1910. No. 13801.

Improvement in Cyanide Practice. E. Gybbon Spilsbury. Describes a mechanical improvement by which agitation of the solution by air passed through silica sponge causes rapid action of the cyanide. Reports tests made with this porous diaphragm. Ills. 3000 w. Bul Am Inst of Min Engrs—May, 1910. No. 14342 F.

Dredging.

Cost of Dredging in Russia and Siberia. W. H. Shockley. Information based on a report of the Commission of Engineers organized to consider the utility of dredges in Russia. 1500 w. Min & Sci Pr—May 7, 1910. No. 13880.

See also Bolivia, under GOLD AND SILVER; and Dredges, under MARINE AND NAVAL ENGINEERING.

Madagascar.

The New Gold Mines in Northern Madagascar (Les Nouvelles Mines d'Or du Nord de Madagascar). Albert Bordeaux. A description of the deposits and their exploitation. Ills. 4000 w. Génie Civil—April 30, 1910. No. 14032 D.

Mexico.

Old Mining Camp of Pozos, Guanajuato, Mex. H. A. Magraw. Outlines the history of this camp where the patio process is being replaced by cyanidation. Ills. 1800 w. Eng & Min Jour—May 7, 1910. No. 13792.

Nevada.

Jarbridge, Nevada. W. A. Scott. An illustrated account of the country, properties, and ores and results of sampling for gold and silver. 2000 w. Min & Sci Pr—April 30, 1910. No. 13768.

New Mexico.

The Black Range Mining District, New Mexico. Martin Fishback. An account of deposits of both high and low-grade ores, yielding both gold and silver. 1200 w. Eng & Min Jour—April 30, 1910. No. 13632.

Ontario.

A Brief Description of the Gow Ganda Silver District in Ontario, Canada. Percy R. Iseman. Brief account of the topography, geology, and economic conditions. Ills. 1000 w. Sch of Mines Qr—Jan., 1910. No. 14302 D.

Rand.

New Policy Adopted in Rand Mining Operations. Owen Letcher. Discusses the substitution of a square fathom stoped for the old unit of a ton milled. 2500 w. Min Wld—May 14, 1910. No. 13932.

Further Notes on Rand Mining. Tom Johnson. Notes on troubles with the roof of working places. Ills. 4400 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1910. No. 13702 E.

Sumatra.

Mining at the Redjang-Lebong Gold-Silver Mine, Sumatra. H. Philp. Information in regard to the old workings, geology, ore bodies, methods, and labor conditions. 2500 w. Jour Chem, Met, & Min Soc of S Africa—March, 1910. No. 13057 E.

IRON AND STEEL.

Analysis.

The Determination of Carbon in Pig and Cast Iron (Kohlenstoffbestimmung im Roh- und Gusseisen). J. Treuheit. Describes a new apparatus for rapid determinations. Ills. 1800 w. Giesserei-Zeit—April 1, 1910. No. 14062 D.

Armor Plate.

The Fabrication of Armor Plate by the Krupp Process (Fabrication des Plaques de Blindage par le Procédé "Krupp"). Ugo F. Gregoretti. A detailed description of the process, translated from *Rivista Marittima*. Ills. 5500 w. Rev de Métal—April, 1910. No. 14005 E + F.

Blast-Furnace Gas.

See Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Blast-Furnace Practice.

Recent Developments in the Metallurgy of Iron. B. Neumann. A résumé of the improvements and experiments, covering furnace practice and construction. 3500 w. Eng & Min Jour—May 21, 1910. No. 14144.

Anthracite Iron Smelting in South Wales. A summary of particulars recently collected by E. Roberts. 1500 w. Ir & Coal Trds Rev—May 13, 1910. No. 14260 A.

Causes of Non-Uniformity of Blast Furnace Operation. Edward B. Cook. Discusses Prof. J. W. Richards' articles on blast furnace practice and the chief difficulty. 3500 w. Met & Chem Engng—May, 1910. No. 13693 C.

Blast Furnaces.

The New Blast Furnace of the Bethlehem Steel Company. W. S. Landis. Il-

We supply copies of these articles. See page 647.

lustrated detailed description. 1000 w. Met & Chem Engng—May, 1910. Serial. 1st part. No. 13687 C.

New Hematite Blast Furnace at Consett. Illustrated description. 1200 w. Ir & Coal Trds Rev—May 6, 1910. No. 13998 A.

New Blast Furnace Plant of the Gutehoffnungshütte. Elevation, detail sections and descriptions of this new plant. 1200 w. Ir & Coal Trds Rev—April 29, 1910. No. 13867 A.

Blowing Engines.

Recent Blowing Engines with Disc Valves (Neuere Gebläsemaschinen mit selbsttätigen Plattenvertilen). Herr Schwanecke. Describes recent Borsig machines. Ills. 2000 w. Stahl u Eisen—April 13, 1910. No. 14056 D.

British Empire.

Iron and Steel Industry of the British Empire. Gives statistics concerning the value of imports and exports, and other features of this industry. 1200 w. Ir & Coal Trds Rev—April 22, 1910. No. 13743 A.

Electrometallurgy.

Electric Furnaces of the Induction Type. T. Rowlands. Read before the Am. Elec.-Chem. Soc. Reviews the progress with the Kjellin furnace and the Röchling-Rodenhauser modification used for large tonnages. 4000 w. Ir Age—May 12, 1910. No. 13870.

An Electric Smelting Furnace. Edward R. Taylor. Illustrated description of the author's design for reducing iron ore. 2200 w. Ir Age—May 19, 1910. No. 14111.

The Girod Furnace. W. Borchers. Read before the Ir. & St. Inst. Illustrated description of an electric furnace for steelmaking, explaining the principles. 3000 w. Elec Engr, Lond—May 6, 1910. No. 13960 A.

The Production and Refining of Steel in the Electric Furnace (Produzione e Affinazione dell' Acciaio al Forno elettrico). Remo Cantani. Reviews progress in the electrometallurgy of steel and discusses its technical and economic possibilities. 8000 w. Riv Marit—April, 1910. No. 14034 E + F.

The Alleged Inequality of the Charge in Electric Induction Steel Furnaces (Ueber die angebliche Ungleichmässigkeit der Chargen in Elektrostahlöfen mit Induktionsheizung). V. Engelhardt. Discusses the effect of variations in temperature in different parts of induction furnaces. Ills. 2200 w. Stahl u Eisen—April 20, 1910. No. 14059 D.

Germany.

The Lorraine-Luxemburg Mining and Iron Industry (Die Lothringisch—Luxemburgische Montan- und Eisenindustrie). M. Ungeheuer. A general review of mining in the minette district. Ills. 7500 w. Tech u Wirt—April, 1910. No. 14246 D.

Hudson Bay.

An Algonkian Basin in Hudson Bay—A Comparison with the Lake Superior Basin. C. K. Leith. Shows the repetition of essentially Lake Superior conditions in the Hudson Bay territory. No discoveries are yet made to warrant commercial comparison. Map. 6000 w. Ec Geol—April, 1910. No. 14313 D.

Open Hearth.

The Attainment of Highest Purity Iron on a Commercial Basis. James A. Aupperle. Illustrated description of the process and product known as American ingot iron. 1200 w. Met & Chem Engng—May, 1910. No. 13697 C.

Production.

Some Factors Affecting the Production and Exports of Iron and Steel. Harold Jeans. Read before the S. Staffordshire Ir. & St. Inst. Considers the relation between export and production, and reviews the destination of the exports of the principal countries and some of the factors affecting them. 2500 w. Ir & Coal Trds Rev—April 22, 1910. Serial. 1st part. No. 13741 A.

Rolling Mills.

Development in the Production of Electric Power: Its Application and Bearing Upon the Iron and Steel Industries. D. L. Selby Bigge. Read before the I. and S. Inst. Discusses progress in England during the past three years, explaining new developments which have reduced the cost of production, especially discussing the possibilities in iron and steel works. Ills. 9000 w. Ir & Coal Trds Rev—May 6, 1910. No. 13989 A.

An Electrically Operated Reversing Blooming Mill. Illustrated description of a recent German plant. 4000 w. Elec Rev, N Y—May 14, 1910. No. 13929.

A Continuous Billet Mill. Illustrates and describes an important addition to the Cambria Steel Co.'s plant at Johnstown, Pa. 2000 w. Ir Age—May 5, 1910. No. 13748.

The New 18-Inch Billet Mill of the Cambria Steel Co. Illustrated description of the Continuous process of rolling billets and ton bar, at Johnstown, Pa. 2500 w. Ir Trd Rev—May 12, 1910. No. 13878.

The Employment of Continuous Roll Trains in German Steel Works (Ueber die Verwendung kontinuierlicher Walzenstrassen auf deutschen Hüttenwerken). F. Schruff. A detailed description of German practice. Ills. 5500 w. Stahl u Eisen—April 13, 1910. No. 14054 D.

See also Engines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Smelting.

Native Iron Smelting in Haute Guinee

(West Africa). J. Morrow Campbell. Read before the Inst. of Min. & Met. Brief description of native iron furnaces, differing from any before recorded. 1500 w. Ir & Coal Trds Rev—April 22, 1910. No. 13740 A.

Steel Making.

Transformetal Process of Changing Iron Into Steel. E. F. Lake. Presents the claims of a process which aims to change all grades of iron into steel. Ills. 2000 w. Am Mach—Vol. 33. No. 19. No. 13876.

Steel Refining.

The Present Status of Steel Refining Processes (Etat actuel du Procéde d'Affinage sur Sole). Otto Petersen. Abstract translation from *Stahl und Eisen*. Discusses the various processes of steel refining in the open-hearth furnace. Ills. 16000 w. Rev de Métal—April, 1910. No. 14002 E + F.

Steel Works.

Power for Modern Steel Works (Die Maschinenanlage auf modernen Hüttenwerken). M. Langer. Discusses the relative merits of steam and gas power, giving preference to the latter. Also number of letters on the same subject. 8500 w. Stahl u Eisen—April 20, 1910. No. 14058 D.

Trade.

Presidential Address before the Iron and Steel Institute. Duke of Devonshire. Reviews the economic conditions which prevailed in the year of the formation of the Institute (1869), and compares them with the present. 5500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13986 A.

LEAD AND ZINC.

Mexico.

The Real de Xichu Mining District, Mexico. Claud Hafer. Brief historical review with description of the principal mining operations now being carried on. The ores are argentiferous galena, pyrite and zinc-blende. Ills. 1800 w. Min Wld—May 21, 1910. No. 14160.

The Cabrillas Lead Mines of Coahuila, Mexico. S. J. Lewis. Gives the early history, geological features, origin and character of the ore, mining methods, etc. Ills. 2500 w. Eng & Min Jour—May 21, 1910. No. 14145.

Missouri.

Developing a New Ore Horizon. Lucius L. Wittich. Concerning the large bodies of zinc ore lying at levels beneath those already developed, at Joplin, Mo. Ills. 3500 w. Mines & Min—May, 1910. No. 13684 C.

Zinc Smelting.

Recent Advances in the Electrometallurgy of Zinc. Franz Peters. Abridged translation from *Glückauf*. Considers smelting processes. Ills. 2500 w. Eng & Min Jour—May 14, 1910. No. 13925.

MINOR MINERALS.

Asbestos.

The Quarries of the Canadian Asbestos District. Fritz Cirkel. Illustrated description of the occurrence, quarries, and mills, production and uses. 1500 w. Eng & Min Jour—April 30, 1910. No. 13634.

Clays.

The West of England China Clay and Stone Company, Limited, St. Austell. Describes the development of a china clay and china stone quarry, explaining how their products are utilized for commercial purposes. Ills. 3000 w. Quarry—May, 1910. No. 13843 A.

Diamonds.

Diamond Mining. Henry Leffman. Brief account of the methods of mining and matters related. Ills. 1500 w. Pro Engrs' Club of Phila—April, 1910. No. 14269 D.

Nickel.

The Nickel-Copper Industry of Ontario. Alex. Gray. Map, and review of discoveries, companies organized, etc. 6500 w. Min Wld—May 14, 1910. Serial. 1st part. No. 13931.

Electric Smelting of Nickel Ore. Illustrated description of a new electric furnace plant for nickel silicide in North Carolina. 1200 w. Met & Chem Engng—May, 1910. No. 13701 C.

Oil.

The Petroleum Fields of the United States. W. G. Burroughs. Briefly describes the characteristics of each of the more important fields. 4000 w. Eng & Min Jour—April 30, 1910. No. 13635.

Development of Coalinga Oil Field, California. Paul W. Prutzman. Map and description of the work accomplished and new developments. 2800 w. Min Wld—May 21, 1910. No. 14161.

Petroleum Development in San Joaquin Valley. Information, from a recent report of the State Mining Bureau, concerning this oil district of California. 3000 w. Eng & Min Jour—May 7, 1910. No. 13793.

A Phenomenal Oil Gusher. Charles Carrol Wright. Illustrated description of the largest oil gusher in the history of California. 600 w. Sci Am—May 21, 1910. No. 14128.

A Natural Naphtha from the Province of Santa Clara, Cuba. Clifford Richardson and Kenneth Gerard Mackenzie. Describes a naturally occurring white naphtha. 1800 w. Am Jour of Sci—May, 1910. No. 14296 D.

Platinum.

Russian Platinum and Foreign Companies in Russia. V. X. Pravdinsky. An explanation of the platinum industry and the control of the situation. 2500 w. Eng & Min Jour—May 14, 1910. No. 13927.

Salt.

Leaching Brine from Salt Mines (So-

We supply copies of these articles. See page 647.

leerzeugung durch Berieselung). C. Schraml. Gives results of this method of salt mining in Austria during 1909. Ills. 2200 w. Oest Zeitschr f Berg- u Hüttenwesen—April 23, 1910. No. 14070 D.

The Grubach and Abtenau Salt Deposits (Das Salzgebirge von Grubach und Abtenau). Hans Reinl. Discusses the extent and exploitation of these salt deposits in Austria. Ills. Serial. 1st part. 2200 w. Oest Zeitschr f Berg- u Hüttenwesen—April 16, 1910. No. 14069 D.

Sodium.

Metallic Sodium from Fused Sodium Chloride. C. F. Carrier, Jr. An illustrated report of investigations giving promising results. 4000 w. Met & Chem Engng—May, 1910. No. 13694 C.

Sulphur.

Employment of Rock Sulphur for Manufacture of Sulphur Acid. Prof. Giuseppe Odds. Discusses the commercial possibility of utilizing rock sulphur for the manufacture of sulphuric acid. 3000 w. Min Jour—April 30, 1910. Serial. 1st part. No. 13850 A.

Tin.

The Assay of Tin Ores. Jas. Gray. Considers the dry assay and the wet analysis. 2500 w. Jour Chem, Met & Min Soc of S Africa—March, 1910. No. 13956 E.

Glimpses Underground. T. A. Rickard. Amusing sketches of Cornishmen at work underground in the tin mines of England, with explanatory notes. 800 w. Min & Sci Pri—May 14, 1910. No. 14133.

MINING.

Boring.

See Wells, under CIVIL ENGINEERING, WATER SUPPLY.

Diamond Drilling.

Cost of Diamond Drilling in Australia. J. Allan Thompson. Explains some petrographical considerations affecting the wear of diamonds. 1200 w. Aust Min Stand—April 13, 1910. No. 14108 B.

Drills.

Hammer Drills in Overhand Stoping and Raising. H. B. Williams. An account of the writer's experience of their performance. Ills. 1500 w. Inst of Min & Met, Bul. 67—April 14, 1910. No. 14354 N.

Electric Hoisting.

Electric Mine-Hoists. D. B. Rushmore and K. A. Pauly. Presents the advantages of the electric hoist, claiming economy, greater safety, adaptation to underground workings, and the possibility by using water power. 8000 w. Bul Am Inst of Min Engrs—May, 1910. No. 14343 F.

Tests of an Ilgner Electric Hoist. R. R. Seeber. Describes the installation of the Winona Copper Co., reporting test. Diagrams. 2000 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14349 F.

Determining Efficiency of Electric Hoist Gearing. S. H. Libbey. Illustrated discussion of spur gear and worm gear types, showing them to be equally efficient. 2000 w. Am Mach—Vol. 33. No. 21. No. 14387.

Electric Power.

Mechanical Defects in Mining Motors. A statement of troubles found in connection with motors installed in mines. Ills. 2000 w. Elec Rev, Lond—May 6, 1910. No. 13961 A.

Direct-Current Distribution on the Series System for Mines (La Distribution par Courant continu en Série dans les Mines). A discussion of the advantages of this system of power distribution in mining work. Ills. 2700 w. Génie Civil—April 30, 1910. No. 14033 D.

Hoisting.

"Whitmore" Overwinding Gear. H. J. H. King. Read before the Nat. Assn. of Col. Mgrs. Illustrated description of the apparatus and its applications. 2800 w. Ir & Coal Trds Rev—May 6, 1910. No. 13999 A.

See also Axles, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Hoisting Cages.

Safety-Clutch Construction for Cages (Notiz zur konstruktiven Ausbildung der Bewegungsmechanismen für bremsend wirkende Fangvorichtungen). Wzl. Macka. Brief discussion of a number of types. Ills. 1000 w. Oest Zeitschr f Berg- u Hüttenwesen—April 2, 1910. No. 14067 D.

Hoisting Engines.

Acceptance Test of a Steam Hoisting Engine (Abnahmeversuche an einer Dampffördermaschine). Describes and gives results of tests of a hoist on the Koepe system. Ills. 1500 w. Glückauf—April 23, 1910. No. 14078 D.

Law.

Geologic Bases of Mining Law. Courtenay De Kalb. Address before the San Francisco Bar Assn. Explains the variety of ore deposits and their sources, and the mining laws of the present, showing that they were formed when knowledge was too limited to cover all the facts. 6000 w. Min & Sci Pr—May 7, 1910. No. 13882.

Ore Thefts.

The Cause and Prevention of "High-Grading." A. H. Martin. Discusses the troubles from theft of ore. 1700 w. Min Wld—May 7, 1910. No. 13803.

Shaft Lining.

Brier Hill Concrete Lined Shaft, Vulcan, Mich. William Kelly. Abstract of a paper read before the L. Superior Min. Inst. Illustrates and describes the lining of a circular shaft 850 ft. deep and 14 ft. in diameter. 1500 w. Eng & Min Jour—May 7, 1910. No. 13794.

We supply copies of these articles. See page 647.

Reinforced-Concrete Shaft and Tunnel Lining (Die zweckmässige Ausbildung des Schacht- und Streckenausbaues in Eisenbeton). Richard Wuczkowski. Mathematical discussion of the design of shaft and tunnel linings. Ills. 7000 w. Glückauf—April 16, 1910. No. 14076 D.

Shaft Sinking.

Electricity in Colliery Sinking Operations. States the principal advantages claimed for electric sinking, and gives illustrated description of the plant at the Hamsterley Collieries. 2000 w. Elec Rev, Lond—May 6, 1910. No. 13962 A.

The New Sinking at Astley, Manchester, Eng. Illustrated description of shafts to be carried to an approximate depth of 950 yards, and 1150 yards respectively. 1200 w. Ir & Coal Trds Rev—April 29, 1910. No. 13868 A.

Sinking Into the Lower Coal Measures in the Hulton Colliery. Abstract of paper by Alfred J. Tonge, and a discussion. Describes the geological features, and gives brief account of the sinking. 3000 w. Ir & Coal Trds Rev—April 22, 1910. No. 13742 A.

Stowing.

An Experiment with a New Method of Stowing (Versuche mit einer neuen Art des Bergeversatzes). Herr Rossenbeck. Discusses a new method employed in German coal mines and its cost. Ills. 3000 w. Glückauf—April 23, 1910. No. 14077 D.

Surveying.

Practical Hints on Underground Surveying. William A. O'Flynn. Suggestions for work in mine surveying. 1500 w. Ap Sci—April, 1910. No. 14284 C.

Ventilation.

Size of Shaft as a Factor in Mine Ventilation (Die relative und normale Grubenweite). Herr Kezel. Mathematical discussion. Ills. 3500 w. Glückauf—April 2, 1910. No. 14073 D.

Examples of Fan Construction (Exemples pris dans le Domaine de la Construction des Ventilateurs). Th. V. Bavier. Describes the various types of fans devised within the last thirty years for mine ventilation. Ills. 3000 w. All Indus—April, 1910. No. 14022 D.

ORE DRESSING AND CONCENTRATION.

Classifiers.

Hydraulic Classification and Flow of Pulp in Launders. A. S. Ostreicher. Illustrates how graphic kinetics can be applied to the computation of diagrams, and gives a study of hydraulic separation. 4000 w. Jour S African Assn of Engrs—March, 1910. No. 13958 F.

Flotation Process.

Oil Flotation Process at Broken Hill, N. S. W. Theodore J. Hoover. Illustrates and describes a plant where zinc and lead sulphides are collected in a froth and floated off; the highest recovery is from slime, and the total cost $1.84 per ton. 2200 w. Eng & Min Jour—April 30, 1910. No. 13633.

Screening.

Clay Screens vs. Drying Ores. H. W. Fox. Illustrated description of an apparatus by which wet ores may be screened without preliminary drying. 1800 w. Mines & Min—May, 1910. No. 13682 C.

Sintering.

Sintering of Fine Ore and a Sintering Machine. Alfales B. Young. Read before the W. Assn. of Tech. Chemists and Metallurgists. Describes the more important processes and gives an illustrated description of apparatus. 2200 w. Met & Chem Engng—May, 1910. No. 13696 C.

Slimes Treatment.

The Elements of Slime Concentration. Walter McDermott. Discusses the recovery of slime material aiming to indicate the most promising directions for improvements. 5800 w. Inst of Min & Met, Bul. 67—April 14, 1910. No. 14352 N.

Stamp Mills.

Limitations of One and Five Stamp Batteries. Algernon Del Mar. Discusses amalgamating results with the single-unit and five-unit stamps, showing that a thorough test is necessary before deciding which to use. 1500 w. Min & Sci Pr—May 7, 1910. No. 13881.

Tailings Disposal.

Handling Tailings at Colorado City. R. L. Herrick. Describes a special form of centrifugal pump and method of distributing tailings. Ills. 3300 w. Mines & Min—May, 1910. No. 13683 C.

Tube Mills.

The Tube-Mill Circuit and Classification. G. O. Smart. Explains how a desirable uniformity of feed can be better secured, than by the classifiers in common use. Ills. 4000 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1910. No. 13703 E.

MISCELLANY.

Assaying.

New Analytical Methods. F. H. Mason. A volumetric method for determining sulphates; a new method for detecting caesium, rubidium, and sodium. 1200 w. Min & Sci Pr—May 14, 1910. No. 14134.

Charcoal.

The Manufacture, Properties and Uses of Charcoals. The characteristics of wood, animal, and gas charcoals are considered and the applications in metallurgy and other fields. 1400 w. Prac Engr—May 6, 1910. Serial. 1st part. No. 13970 A.

Hungary.

The Exploitation of Hungarian Ore Deposits (Ungarische Erzlagerstätten, ihre Ausbeutung und die Zugutemachung der Erze). Herrn Arlt and Scheffer. Describes various ore deposits and methods of extraction. Ills. 10000 w. Glückauf—April 9, 1910. No. 14074 D.

We supply copies of these articles. See page 647.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signalling.

Railway Signalling. Prof. V. J. Smart. The present number discusses block signalling, its advantages and weaknesses. 3000 w. Can Engr—May 6, 1910. Serial. 1st part. No. 13817.

Combination Lock and Block and Automatic Signals for Single-Track Sections, Central New England Ry. Illustrated description of system, and explanation of conditions. 3000 w. Ry & Engng Rev—May 14, 1910. No. 13936.

See also Switches, under PERMANENT WAY AND BUILDINGS.

Wages.

A New Principle for Fixing the Wages of Railway Employees. Editorial criticism of the decision rendered by the federal board of arbitration at Chicago, regarding wages to be paid by the railways to members of the Switchmen's Union. 1200 w. Ry Age Gaz—May 20, 1910. No. 14137.

New York Central Wages. Gives the decision of the arbitrators in the case of the N. Y. C. & H. R. conductors and trainmen. 2500 w. Ry Age Gaz—May 13, 1910. No. 13902.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Maintenance. Discusses improper repairs. 1500 w. Ry & Loc Engng—May, 1910. No. 13638 C.

Tests to Determine the Effect of Low Temperatures on Air Brake Hose and Coupling Gaskets. From a paper by W. J. Hatch at meeting of the Air Brake Assn. Describes tests. 1100 w. Ry Age Gaz—May 20, 1910. No. 14139.

Air Pumps.

Air Pump Piping. Extracts from the report of the Committee on Air Pump Piping, presented at Indianapolis, before the Air Brake Assn. Ills. 3500 w. Ry & Engng Rev—May 21, 1910. No. 14159.

Depreciation.

Equipment Depreciation and Replacement. William Mahl. A statement showing the per cent of cost of equipment vacated to total original cost for certain roads. 1000 w. Ry Age Gaz—May 20, 1910. No. 14138.

Freight Cars.

Stresses Developed by Collisions of Freight Cars. Col. B. W. Dunn. Explains the necessity of a thorough investigation of these stresses, discussing the tests at Altoona and their results. Ills. Also general discussion. 9500 w. Pro N Y R R Club—April 15, 1910. No. 14279.

Railway-Car Construction in America (Mitteilungen über eine Studienreise nach Amerika, insbesondere über Eisenbahnwagenbau). Herr Nicolaus. A German view. Ills. 7000 w. Glasers Ann—April 15, 1910. No. 14202 D.

New Closed and Covered Cars, Entered from the Ends, for Transportation of Automobiles on the Paris-Lyons-Mediterranean Railway (Note sur les nouveaux Wagons converts et fermés avec Entrée par Bouts, pour le Transport de Voitures automobiles, de la Cie. P. L. M.). M. Lancremon. Illustrated description. Plates. 1000 w. Rev Gen d Chemins de Fer—April, 1910. No. 14009 G.

Locomotive Boilers.

Report on the Question of Improvements in Locomotive Boilers. Johann Papp. Discusses practice in Austria-Hungary, Rumania, Bulgaria, Servia and Turkey with boilers with smoke tubes, damages, purification of feed-water, etc. 14300 w. Bul Int Ry Cong—April, 1910. No. 14363 G.

Locomotive Construction.

Report on the Question of the Use of Steel. Otto Hönigsberg. Report for countries belonging to the "Verein Deutscher Eisenbahn-Verwaltungen" on the use of special steel of high resistance in the making of parts of locomotives and rolling-stock. 15400 w. Bul Int Ry Cong—April, 1910. No. 14366 G.

Locomotive Costs.

Increases in Motive Power Expenses Due to Severe Weather. Examines the heavy increase in the expense of motive power of various railways, especially in the West, due, it is believed, to severe weather conditions. 1500 w. Ry Age Gaz—May 13, 1910. No. 13899.

Locomotive Design.

British Engineers on Compounding and Superheating. Thomas Reece. Gives a statement by Mr. George Hughes of the present position of British experience in these matters, and a report of investigations and comparative tests. 1600 w. Mach, (Ry Ed)—May, 1910. No. 13911 C.

Locomotive Fuels.

An Efficient Fuel Department. Description of the organization, methods of accounting and operation of the fuel department of the A., T. & S. F. Ry. which has shown remarkable results. Ills. 3500 w. Am Engr & R R Jour—May, 1910. No. 13832 C.

Locomotive History.

Links in the History of the Locomotive. Information concerning the Blenkinsop rack locomotive, of 1812. Also description translated from the French. 3000

We supply copies of these articles. See page 647.

w. Engr, Lond—April 29, 1910. No. 13861 A.

Locomotive Inspection.

A General Locomotive Inspection. R. H. Rogers. An account of the method of procedure, some of the results and the conclusions following a detailed individual inspection of over fifteen hundred locomotives of all types and sizes. 4500 w. Am Engr & R R Jour—May, 1910. Serial. 1st part. No. 13835 C.

Locomotive Oscillations.

The Stability of Locomotives (Considerazioni sulla Stabilita delle Locomotive). E. Grismayer. A mathematical discussion. Serial. 1st part. 7500 w. Ann d Soc d Ing e d Arch Ital—March 15, 1910. No. 14037 F.

Locomotive Performance.

Locomotive Performance on Grades of Various Lengths. Beverley S. Randolph. Gives data collected from practical operation of various roads, with explanation. 2500 w. Pro Am Soc of Civ Engrs—April, 1910. No. 14339 E.

Locomotives.

Recent Developments in American Locomotives. A review of recent types built for the different railway lines. 3500 w. Engr, Lond—May 13, 1910. No. 14251 A.

Consolidation Locomotive, Chicago, Milwaukee & St. Paul. Illustrated detailed description. 600 w. Ry Age Gaz—May 6, 1910. No. 13814.

Passenger 4-6-0 for the Seaboard Air Line Railway. Illustrated description. 600 w. Ry & Loc Engng—May, 1910. No. 13637 C.

The Latest Giant Freight Engine. Illustrated description of the large articulated freight engine for use on the heavy grades of the Delaware & Hudson R. R. 600 w. Sci Am—May 28, 1910. No. 14396.

Atlantic Type Locomotives for the Baltimore & Ohio. Illustrated detailed description of type known as "A-3," a straight-forward design of high-speed engine. 1000 w. Ry Age Gaz—May 29, 1910. No. 14140.

Mallet Articulated Compound Locomotive. 2-6-6-2 Type. Illustrated description of locomotive design which is arranged to burn lignite and is equipped with a high degree superheater and reheater and a very large capacity feed-water heater. 1200 w. Am Engr & R R Jour—May, 1910. No. 13833 C.

Mallet Locomotive for the Burlington. Illustrated detailed description of the 2-6-6-2 type built for the C., B., & Q. Ry., with reheater and feed-water heater. 1800 w. Ry Age Gaz—May 13, 1910. No. 13901.

New Model Locomotive at South Kensington. Describes a sectional model of a 6-wheeled single driven engine of the type generally used on British railways about 1840. 900 w. Engr, Lond—April 29, 1910. No. 13863 A.

Heavy Narrow Gage Pacific Type Locomotive for the Central South African Railways. Illustrated detailed description. 1500 w. Ry & Engng Rev—April 30, 1910. No. 13658.

Six-Coupled Locomotive for the Tientsin-Pukow Railway, China. Illustration, with brief description. 400 w. Engng—May 13, 1910. No. 14198 A.

The Garratt Flexible Railroad Locomotive. Illustrated description of a design for operation on steep grades and sharp curves. 1000 w. Sci Am Sup—May 28, 1910. No. 14398.

Powerful Freight and Passenger Locomotives for a Narrow Gauge Railway. Illustrated description of a Mallet compound 2-6-6-2 type, and a Pacific type locomotive recently constructed for the Central South African railway. 2000 w. Am Engr & R R Jour—May, 1910. No. 13836 C.

The 3/6 Coupled Express Locomotives, Series 210, of the Austrian State Railways (Die 3/6-gekuppelten Schnellzuglokomotiven Serie 210 der k. k. österreichischen Staatsbahnen). Herr Metzeltin. Detailed description. Ills. 6500 w. Zeitschr d Ver Deutscher Ing—April 2, 1910. No. 14232 D.

Recent Experiments on the Application of the Steam Tubrine to Locomotives (Recenti Esperienze sulla Applicazione delle Turbine a Vapore alle Locomotive). G. Belluzzo. Reviews results of tests made in Italy. Ills. 1200 w. Industria—April 10, 1910. No. 14038 D.

Locomotive Safety Valves.

Safety Valve Adjustment. Explanatory comments. 1000 w. Ry & Loc Engng—May, 1910. No. 13639 C.

Motor Cars.

Report on the Question of Motor Vehicles. T. Hurry Riches. Report for Great Britain and colonies on the use and cost of motor vehicles or self-moving cars. Ills. 17000 w. Bul Int Ry Cong—April, 1910. No. 14364 G.

Accumulators for Electric Motor Cars (Ueber Akkumulatoren für Eisenbahn-Triebwagen). M. Büttner. Discusses the extension of the use of electric motor cars and describes types of batteries in use. Ills. 4500 w. Elek Kraft u Bahnen—April 14, 1910. No. 14222 D.

Shops.

Car Repair Shop Notes from the Erie Railroad at Buffalo. Roy V. Wright. Illsutrates and describes methods and interesting work. 3000 w. Ry Age Gaz—May 6, 1910. No. 13813.

Locomotive Building at the Juniata Shops. Ralph E. Flanders. Illustrates and describes machine shop work on

We supply copies of these articles. See page 647.

axles, wheels, centers, tires and crank pins. 5000 w. Mach, (Ry. Ed.)—May, 1910. No. 13910 C.

Train Resistance.

Freight Train Resistance. Prof. Edward C. Schmidt. Describes tests made to determine its relation to average car weight. Ills. 11000 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14329 F.

NEW PROJECTS.

Italy.

The Splugen Pass Railway (Il Passaggio ferroviario dello Spluga). Giuseppe Colombo. A general discussion of the project. Ills. 5000 w. Ann d Soc d Ing e d Arch Ital—March 15, 1910. No. 14036 F.

PERMANENT WAY AND BUILDINGS.

Bridges.

Report on the Question of Strengthening the Bridges with a View to Increasing the Weight of Locomotives and the Speed of Trains. Eugene Randich. Report for France and Italy on methods of strengthening metal bridges. Ills. 30500 w. Bul Int Ry Cong—April, 1910. No. 14365 G.

See also under CIVIL ENGINEERING, BRIDGES.

Construction.

Construction of the Kansas City, Mexico & Orient Ry. Gives an account of the construction work, with illustrated descriptions of some of the engineering work. 3000 w. Ry & Engng Rev—April 30, 1910. No. 13657.

Curves.

The Application of the Hallade Method of Joining Curves (Résumé, Modèles et Tables numériques pour l'Application de la Méthode de Raccordement des Courbes donnée par. M. Hallade). Gives tabular data and examples for the application of the method proposed by M. Hallade in 1908. Ills. 10000 w. Rev Gen d Chemins de Fer—April, 1910. No. 14010 G.

Freight Sheds.

The Location and Arrangement of Freight Houses and the Handling of House Freight. M. A. Long. Brief description of present arrangements for cities and smaller places. Ills. 1500 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14356 N.

Mail Exchange.

The Sebree Mail Exchanging Device. Illustrated description of a devise being tested by the Illinois Central R. R. 700 w. Ry & Engng Rev—May 7, 1910. No. 13806.

Rail Joints.

Report on the Question of Rail-Joints. Mr. Blum. Report for all countries except France, Belgium, Italy, Spain, Portugal, Austria-Hungary, Rumania, Bulgaria, Servia, Turkey, Egypt and countries using the English language. Ills. 6000 w. Bul Int Ry Cong—April, 1910. No. 14367 G.

Report on the Question of Rail-Joints. Mr. Chateau. Report for France, Belgium, Italy, Spain, and Portugal on practice of reducing the number of joints by increasing the length of the rails, welding and strengthening joints. Ills. 14000 w. Bul Int Ry Cong—April, 1910. No. 14362 G.

Stations.

The Terminal in Buffalo. George Cary. Brief illustrated description of the plans for a union station, and matters related. 1300 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14359 N.

New Union Passenger Station, Winnipeg. Illustrated detailed description. 1500 w. Eng Rec—May 21, 1910. No. 14156.

Switches.

Report on the Question of the Operation of Switches and Signals. L. H. N. Dufour. Report for Holland on improved centralized installations, and arrangements adopted. Ills. 14000 w. Bul Int Ry Cong—April, 1910. No. 14361 G.

Terminals.

A Terminal Station. J. Vipond Davies and J. Hollis Wells. Illustrations, and description of the Hudson terminal buildings in New York City, explaining the conditions and the development. 7500 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14357 N.

See also Tunnels, under CIVIL ENGINEERING, CONSTRUCTION.

Ties.

Keeping Records of Test Ties. F. J. Angier. Describes the system used by the Chicago, Burlington & Quincy. 1200 w. Ry Age Gaz—May 6, 1910. No. 13807.

TRAFFIC.

Car Interchange.

Report of Standing Committee on Revision of M. C. B. Rules of Interchange. A discussion of the recommendations of the Committee. 11000 w. Pro Ry Club of Pittsburgh—March 25, 1910. No. 14278 C.

Report of the Committee on the Master Car Builders' Rules of Interchange. Discussion of the rules in their order. 14500 w. Pro W Ry Club—March 15, 1910. No. 14276 C.

Coal.

See Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Freight Handling.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Freight Rates.

Reasonable Freight Rate. F. H. Plaisted. Discusses the making of rates aiming to remove public misapprehension. 4000 w. Ry Age Gaz—May 13, 1910. Serial. 1st part. No. 13897.

We supply copies of these articles. See page 647.

Fair Return on the Value of Property a Fallacious Standard. Walker D. Hines. From an address before the Traffic Club of Pittsburgh. A discussion of rates and equitable bases for government regulation. 1700 w. Ry Age Gaz—May 6, 1910. No. 13809.

Mine Suspensions.

Economic Losses Due to Mine Suspensions. Eugene McAuliffe. A discussion of the losses from this cause, and the possible remedy; referring to legislation in Canada and the benefits. 2500 w. Am Engr & R R Jour—May, 1910. No. 13834 C.

Passenger Rates.

Reformed Passenger Tariffs in Italy. Ph. Tajanie. An account of the tariff reforms made by roads under state management, explaining the new tariff. 1800 w. Ry Age Gaz—May 6, 1910. No. 13810.

STREET AND ELECTRIC RAILWAYS.

Cars.

Vestibule or No Vestibule. Henry Mozley. Considers the advantages, construction, design, and use. Ills. 1200 w. Tram & Ry Wld—May 5, 1910. No. 14107 B.

Dublin.

The Dublin United Tramways Company. Illustrates and describes the lines operated by the United Company, giving information in regard to rolling-stock, traffic, power-stations and other subjects of interest. 2500 w. Tram & Ry Wld—May 5, 1910. No. 14106 B.

Electric Traction.

The Development of Electric Railways in the United States (Développement des Chemins de Fer électriques aux Etats-Unis d'Amérique). H. Marchand. A review of the development of the various traction systems. 1000 w. Soc Belge d' Elecns—April, 1910. No. 14000 E.

Italy.

The Padua-Fusina Alternating-Current Railway (Die Wechselstrombahn Padua-Fusina). C. H. Eigenheer. Illustrated detailed description of line and rolling stock. Serial. 1st part. 1600 w. Elek Kraft u Bahnen—April 23, 1910. No. 14223 D.

Locomotives.

Electric Locomotives with Connecting Rods (Comportamento delle Bielle motrici nelle Locomotive elettriche). Emidio Pacilli. A study of this mode of transmission in electric locomotives. Ills. 2200 w. Industria—April 17, 1910. No. 14040 D.

Paris.

The Railways of Paris (Die Pariser Stadtbahn). E. A. Ziffer. A brief description of the construction, stations, rolling stock, operation, etc., of the Metropolitan of Paris. Ills. 5500 w. Mitt d Ver f d Förd d Lokal- u Strassenbahnwesens—March, 1910. No. 14050 F.

Rail Joints.

Rail Joints for Interurban Lines (Il Giunto nella Tramvia extraurbana). Illustrates various types in use. 1800 w. Ing Ferro—April 1, 1910. No. 14043 D.

Railless.

Railless Electric Railways (Gleislose elektrische Bahnen). A. Heller. A brief discussion and description of cars for trackless trolley lines. Ills. 2200 w. Zeitschr d Ver Deutscher Ing—April 30, 1910. No. 14242 D.

Single-Phase.

Blankenese-Ohlsdorf High-Tension, Single-Phase Railway. Gustav Dietl. Illustrates and describes characteristics of the new equipment. 900 w. Elec Wld—May 12, 1910. No. 13915.

Stations.

Inter-Urban Stations and Trolley Traffic in City Streets. Albert Kelsey. Brief discussion of arrangements of tracks, waiting stations, etc. 2500 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14360 N.

Subways.

The Proposed Suburban Railways of Sydney. C. O. Burge. Map and discussion of the proposed lines. 2500 w. Engr, Lond—April 29, 1910. No. 13856 A.

How Chicago is Solving Its Rapid Transit Problem. D. H. Stevens. Illustrated description of the proposed plan for placing all tracks, surface and elevated, that enter the business zone, below street level. 1200 w. Sci Am—May 28, 1910. No. 14397.

Subway Ventilation.

Ventilation of the Hudson River Tubes. A. W. Hodgson. Describes the system installed in the tunnels of the Hudson & Manhattan R. R. Co., reporting test. Ills. 3000 w. Heat & Vent Mag—May, 1910. No. 14306.

Three Phase.

Three-Phase Railways in Europe. Rudolph E. Hellmund. Brief illustrated descriptions of features of the European three-phase roads. 3500 w. Elec Jour—May, 1910. Serial. 1st part. No. 14287.

Valuation.

Valuation of the Puget Sound Electric Railway. Henry L. Gray. Describes the lines and methods of valuation. 8000 w. Engng-Con—May 25, 1910. No. 14395.

We supply copies of these articles. See page 647.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first instalment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or a book of twelve for $2.00; three books for $5.00.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.